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An Outbreak of Milk-Borne Typhoid Fever

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BECAUSE of great advances in the supervision of water supplies, and the pasteurization of milk supplies, typhoid fever has become progressively less frequent. The typhoid mortality rates to-day in most countries are so low that they might be interpreted as meaning that we are safe from this disease. This hope, however, is periodically discouraged by epidemics having their origin in infected milk.

It is well known that the basis of many of our typhoid outbreaks is the combination of an unpasteurized milk supply and a typhoid carrier. Until recent years little systematic attempt has been made to recognize and supervise those who have continued as carriers following recovery from typhoid. The percentage of those continuing to shed the organisms is variously estimated as from 2 to 10 per cent, the lower figure being the usual experience in this state. It is inevitable, then, that occasionally a previously unrecognized carrier will be employed on a milk farm and consequently, since there are still many towns in Massachusetts that make pasteurization of milk an alternative instead of an addition to tuberculin testing of cattle or have no milk regulations at all, milk-borne typhoid will from time to time appear.

This report deals with an outbreak of some twenty-eight cases of typhoid fever about equally divided between two contiguous towns and definitely traced to one, fortunately small, milk supply which was from an inspected source, from tuberculosis free cows, but not pasteurized.

Clinical Picture

The onset in the majority of the cases was one in which bronchial symptoms predominated. The outbreak occurring as it did in late December, a period of normally high seasonal incidence of respiratory disease, this was not a little confusing. The occurrence, however, in one day of several cases presenting symptoms suggestive of typhoid in the practice of a local physician, prompted him to call in the local health

officer. Serological and bacteriological examination of blood, feces and urine confirmed the diagnosis.

Epidemiology

The towns of Stockbridge and Lee lie side by side, and the population of Stockbridge is so distributed that it gradually merges into the village of South Lee. The main village of Lee is three miles farther north east. Stockbridge has a population of seventeen hundred and South Lee a population of about two hundred.

Investigation revealed that all the cases under the physician's care at that time were on one milk route handling forty quarts of raw milk a day. This route was long and ran through South Lee into Stockbridge and supplied families of several economic levels. A search for some other common factor among the cases revealed nothing. Additional cases were discovered until a total of twenty-five involving eleven families was reached; all still on the one small milk route. Of these eleven families, six used the Stockbridge town water supply, four used water supplied by a South Lee mill, and one had its own well. Similarly, there was no history of a supper or a party to which all the cases had gone, nor had they a common food source. A survey of the rest of the two towns comprising about two thousand people revealed no cases other than the twenty-five already found on the original milk route. Long before the investigation was complete the epidemiological evidence on hand warranted an emergency pasteurization order being enforced on the milk dealer whose milk supply was under suspicion pending definite proof of the source of infection.

Careful histories taken on the farm revealed that the father, the mother, and the oldest daughter were each responsible for certain duties in the preparation of the milk for sale. The father looked after the farm and milked nine of the eleven cows which comprised the producing herd; the mother milked the remaining two, washed all utensils, and did the bottling; and the oldest daughter helped with the utensils. None of these three gave any history of typhoid and they had been engaged in the milk business with the same milk route for the past four and a half years. Widal tests and stool specimens were taken from the three concerned with the milk. The Widal test of the mother showed partial agglutination and typhoid bacilli were found in her stools. The specimens from the other two were negative. Further investigation revealed that about two weeks before the onset of the outbreak the mother had had for one day a violent gastro-intestinal upset with diarrhoea and vomiting. She was so sick, she said, that she was unable to milk her allotted number of cows. She did, however, manage to complete the washing of the bottles and the bottling of the day's supply. Careful questioning again failed to disclose any past illness which could be considered unrecognized typhoid fever.

As soon as the definite evidence of a carrier on the milk farm was obtained, further sale of milk from this farm was prohibited. Thus

another carrier was found at the final cost of twenty-five milk-borne cases of typhoid, three contact cases, two deaths, and overdrawn appropriations of the boards of health of two towns.

The outbreak showed many of the classic features of a milk-borne typhoid fever outbreak; the onset was explosive; the majority of the cases were among children; the cases were limited to one milk route; the cases occurred in winter time when typhoid incidence is ordinarily low; the source of infection was a typhoid carrier; and the vehicle of spread was unpasteurized milk.

Analysis of Cases

There were twenty-five cases which can be considered definitely as due to the consumption of infected milk. The date of onset in these cases ranged from December 17 to December 25, 1931. In each of the twenty-five cases there was a positive history of using milk as a beverage. Of these twenty-five cases, 72 per cent occurred in the age group 0-14, an age group in which milk is used extensively for drinking purposes. (See Table I.)

TABLE I

DISTRIBUTION OF CASES BY AGE GROUPS

Age Group	No. of Cases	Per cent of Total Cases
0-14	18	72
15-29	5	20
30-49	2	8
Total	25	100

The earliness of onset for three of the adults (December 18) engaged the attention of the health department. It was found that Mr. *A*, age 40, was suffering from a gastric ulcer and was on a milk diet at the time of his infection; Mr. *B*, age 44, was very fond of milk and rarely if ever failed to have a glass of milk with his meals and always had one on retiring; Mrs. *C*, age 24, had a new born baby and was drinking extra milk for the good of the child.

Two families *X* and *Y* refused typhoid immunization for the well members of the family and in family *X* two contact cases with onsets on January 8th and February 6th occurred, and in family *Y* one contact case occurred on January 20th.

The milk route on which the cases occurred supplied twenty-six families in which there were ninety-four persons. Of these ninety-four persons, twenty-five were primarily infected from the milk, which is an attack rate of 27 per cent. This rate is based, however, on the erroneous assumption that all of the ninety-four persons used the milk in the raw state and were equally exposed. If we consider only those who used milk in the raw state (see Table II) the attack rate becomes 40 per

cent. Further, if we consider only age groups 0-9 and 10-14 (both age groups in which milk is used extensively as a beverage) we find therein twenty-one of the twenty-five cases and an attack rate of 60 and 64 per cent respectively. The outbreak, then, was marked by a high attack rate for milk-borne typhoid and, as could be expected, the cases were concentrated in the milk drinking age groups.

TABLE II

AGE OF PERSONS EXPOSED AND NUMBER OF CASES OF TYPHOID FEVER

Age Group	Persons on milk route				Cases	Attack rate	
	Did not use milk	Used milk cooked	Used raw milk	Total		Among persons on milk route	Among persons using raw milk
0- 9	2	..	20	22	12	55%	60%
10-19	1	..	14	15	9	60%	64%
20-29	2	..	14	16	2	13%	14%
30-39	..	9	4	13	..	....	....
40-49	1	8	8	17	2	12%	25%
50-59	..	4	..	4	..	....	....
60-69	1	3	..	4	..	....	....
70 and over	..	..	3	3	..	....	....
Total	7	24	63	94	25	27%	40%

Summary

Twenty-five cases of typhoid fever were definitely traced to a forty quart, inspected but unpasteurized, milk supply from a tuberculin tested herd. Three contact cases occurred among the non-immunized members of the originally infected families. The attack rate among the persons using the milk was 40 per cent. There were two deaths, giving a case fatality rate of 7 per cent. A typhoid carrier was found among the milk handlers on the suspected farm. The outbreak occurred two weeks after a change in the usual routine of the carrier, *i.e.*, a gastro-intestinal upset with diarrhoea. The outbreak presented many of the classical text-book postulates of a milk-borne typhoid outbreak.

Conclusion

Important as the tuberculin testing of cattle and the periodic analyses of milk samples are, particularly in assuring the production of clean milk from healthy cows—a milk fit to be pasteurized—they do not protect from milk-borne typhoid fever. To safeguard the public health and to assure the consumer of a good product, milk regulations should require that milk sold within a town be: "From tuberculosis free herds; from inspected sources; of good quality; and pasteurized."

Importance and Value of Softening Municipal Water Supplies*

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PURE water, in the strict sense of the term, is very rare, not only in nature, where in fact it is non-existent, but also in the technical laboratory. Owing to its solvent action on a vast number of substances, it is only with meticulous care that pure water can be obtained. Conductivity water, for instance, which is probably the purest of waters, can be prepared only with the aid of rather elaborate equipment and the exercise of extreme caution.

It must be remembered, however, that minute amounts of foreign matter are of more significance in water than in most other commodities. Impurities in most products are expressed in tenths or hundredths of a per cent, that is, in parts per 1,000 or per 10,000. In the case of water, the usual method of expression in this country is in parts per million, and in some instances parts per billion. For example, manganese present in water to the extent of 0.5 part per million—*i.e.*, five one-hundred-thousandths of one per cent—would lead to complaints regarding the staining of laundry, plumbing fixtures, etc., and water containing 1 part of phenol in 50 million—*i.e.*, two-millionths of one per cent—on chlorination, would have a taste which would render it almost undrinkable.

Fortunately, pure water from a hygienic viewpoint, while occurring in nature only in sections of the country remote from human habitation, is by no means rare. Due to the remarkable progress made in the art of water purification during the past two decades, water derived from sources which are badly contaminated can be rendered fit for human consumption. The public, however, are becoming more and more exacting in their demands, requiring not only that the water supply of their community be safe from the standpoint of transmission of disease, but also that it be of pleasing appearance, free from disagreeable tastes and odours, non-corrosive, and of such a degree of hardness that its use will not entail an excessive waste of soap or any of the other objectionable effects associated with hard water.

Types of Hardness

The property of water known as hardness is due chiefly to the presence of calcium and magnesium salts in solution. Rain and snow, the original source of all water supplies, contain very little matter in solution except atmospheric gases, but as the water percolates through the soil and flows through underground and surface channels to join larger bodies of water it dissolves hardness salts, and other impurities, from the rocks, etc., with

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which it comes in contact. Industrial wastes, mine drainage, etc., also contribute to the hardness.

The chief hardness salts are the bicarbonates, carbonates, sulphates, and chlorides of calcium and magnesium. Iron and aluminium salts also add to the hardness, but these are relatively unimportant in this regard. Hardness is of two types, carbonate and non-carbonate. As the term implies, carbonate hardness consists of the carbonates and bicarbonates, while the non-carbonate hardness consists of the sulphates and chlorides. The latter are soluble to a considerable extent in water but the carbonates, particularly calcium carbonate, are relatively insoluble. When carbon dioxide is present, however, which is invariably the case in natural waters, being a constituent of the atmosphere and a product of the decomposition of organic matter, it reacts with the carbonates, forming the bicarbonates, which are much more soluble.

The fact that carbon dioxide greatly increases the solubility of calcium and magnesium carbonates is of great importance, and is the controlling factor in most of the commonly employed precipitation methods of water softening. Thus any process—such as boiling, for instance—which will remove the carbon dioxide, will cause the carbonates to deposit. If carried to completion, only that portion of the carbonates which is truly soluble, about 15 p.p.m. (1, 2) in the case of calcium carbonate and 100 p.p.m. (3) in the case of magnesium carbonate, will remain in solution. The sulphates and chlorides, being soluble, are unaffected by boiling.

In the earlier texts on water treatment, the carbonate hardness was usually referred to as temporary hardness, due to its being deposited on boiling, and the non-carbonate hardness as permanent hardness. The carbonates, however, as previously explained, are not rendered completely insoluble by boiling, and therefore temporary hardness is not synonymous with carbonate hardness, and the residual, or truly soluble portion of the carbonate hardness, should be included in the permanent hardness. The latter is also sometimes termed "incrustants," due to the fact that it forms a hard scale in boilers. The more accurately descriptive terms, carbonate and non-carbonate, are preferable. For convenience, all forms of hardness are expressed in equivalents of calcium carbonate.

Precipitation Methods of Softening

The method most commonly employed for the softening of water is the lime process discovered by Dr. Thomas Clark, of Aberdeen, in 1841. This is simply another means of removing the carbon dioxide which enables the carbonates to remain in solution. The lime, in the form of calcium hydroxide, combines with the carbon dioxide, forming more calcium carbonate, which, together with that originally present, separates as a white solid. The small amount which is truly soluble, of course, remains in solution. Owing to the solubility of magnesium carbonate, 100 p.p.m., an additional equivalent of lime must be added, which decomposes the magnesium carbonate, forming calcium carbonate and magnesium hydroxide. The latter, being nearly insoluble, 6.4 p.p.m. (4), is deposited with the calcium carbonate.

A very great advantage of this process is that the softening reagent is deposited with the hardness removed. There is no new compound formed which remains in solution, and, consequently, the total amount of impurities present is reduced approximately to the same extent as the hardness.

This cannot be accomplished in the case of the non-carbonate hardness, which must first be converted to the corresponding carbonates. This is effected by addition of soda ash, which decomposes the calcium and magnesium sulphates and chlorides, forming sodium sulphate and chloride and calcium and magnesium carbonates. The magnesium carbonate must then be converted to the hydroxide, as previously explained, which will settle out with the calcium carbonate. The sodium sulphate and chloride formed, being very soluble, remain in solution. As the sodium combining weight is greater than that of either calcium or magnesium, the total amount of substance in solution is actually increased. This method, which was discovered by Porter, is widely used in conjunction with Clark's lime method under the name Clark-Porter process, or, more commonly, the lime-soda process.

The amounts of lime and soda required can be calculated from an analysis of the water to be treated. After adding the necessary chemicals and agitating for the required length of time, the water is passed through settling basins or clarifiers to remove the precipitated hardness salts. Alum is frequently added to aid settlement.

Water so treated, owing to the fact that deposition of the carbonates is not complete when the water leaves the sedimentation basin, frequently leads to the formation of carbonate deposits on the filter sand and in the distribution system. This condition can be remedied by treating the softened water, after sedimentation, with sufficient carbon dioxide to convert the undeposited carbonates into the stable bicarbonate form. In principle, this process, which is known as recarbonation, is just the Clark process reversed. Thus lime treatment consists of removing carbon dioxide so that the carbonates will precipitate, while recarbonation consists of adding carbon dioxide so that the residual hardness will remain in solution. The carbon dioxide is usually generated by burning coke, oil or gas in a suitable furnace, the resulting gas being purified by scrubbing before being introduced into the supply.

Great progress has been made in the art of water softening during the past decade, particularly during the last five years. One great difficulty which had been experienced since softening was first practised was that the theoretical reduction in carbonate alkalinity could not even be closely approximated, a residual of 50 to 60 p.p.m. being considered excellent. Recent developments, however, have made it possible to reduce the hardness to almost the theoretical limit.

In 1927, J. M. Montgomery reported in some detail on the results obtained at Piqua with excess lime treatment (5). He found that by adding sufficient lime to produce a caustic alkalinity of 40 p.p.m. and carbonating, after settlement, until the total alkalinity minus twice the phenolphthalein alkalinity equalled approximately 5, the carbonate hardness could be reduced to 20-25 p.p.m. Lime treatment, as ordinarily practised—*i.e.*, maintaining a caustic alkalinity of 5 p.p.m. in the treated water—would only reduce the carbonate hardness to 50-55 p.p.m. Moreover, he reported that this additional softening was effected at a cost per part per million of hardness removed of a little more than one-half the cost of ordinary lime treatment.

J. R. Baylis (6), in a laboratory study of the softening of Lake Michigan water which has thrown considerable light on the chemistry of the lime softening process, reported similar results. He showed that when carbon dioxide is

added to a saturated solution of calcium hydroxide, which has a pH value of 12.35 at 20°C., the hardness decreases until a minimum value of 13 p.p.m. is reached at pH 9.4. Similarly, he found that the saturation equilibrium of magnesium hydroxide is about 3 p.p.m. of magnesium at pH 10.6. These observations indicate that best results should be obtained by adding sufficient lime to increase the pH value to above the point of precipitation of magnesium, removing the precipitated magnesium hydroxide, recarbonating to the point of minimum solubility of calcium carbonate, and, after removal of the carbonate precipitate, recarbonating to stabilize the residual carbonate hardness.

One disadvantage associated with the excess lime and recarbonation method as used at Piqua and, subsequently, at several other places, is that when the water is passed through filters the sand in the latter becomes badly incrusted with calcium carbonate, necessitating spading and crushing of the hard lumps at intervals, and, ultimately, replacement of the sand bed. A modification devised by C. P. Hoover (7), which consists of adding calcium carbonate and settling prior to filtration, has eliminated this difficulty and rendered the process more generally applicable by making less necessary the strict supervision required by the original method. He recommends the following procedure: Apply 25-50 p.p.m. of lime in excess of that theoretically required, settle, neutralize the excess lime with carbon dioxide, mix with large excess of calcium carbonate, softening sludge or other inert finely divided material, settle and, finally, filter. The resulting water will be chemically balanced and will not cause corrosion or incrustation. A patent has been granted in the United States covering this process (8).

Softening by Base Exchange

Another method of softening water is that known as base exchange, which consists of passing the water through a bed of zeolite contained in a filter similar in construction to the ordinary rapid sand type. Zeolites are compounds of aluminum, silica and sodium (or potassium), which occur in nature or may be prepared artificially. They possess the property of exchanging their sodium for other basic radicals in solutions with which they come in contact. Thus, for example, when water containing calcium carbonate is passed through a bed of zeolite the calcium replaces the sodium of the zeolite, the calcium being retained and the sodium liberated, the filtrate containing sodium carbonate instead of calcium carbonate. This reaction is reversible and when all the sodium has been replaced by calcium or magnesium, the material may be restored to its original form by passing a solution of common salt through the bed, the sodium being retained by the zeolite and the calcium and magnesium liberated, the latter flowing to waste with the spent salt solution. After washing out any remaining brine, the filter is ready for service again.

A water of practically zero hardness may be produced by this method, but, as in the case of removal of non-carbonate hardness with soda ash, the content of total solids is increased to a certain extent. This is a disadvantage when the water is to be used for boiler purposes. Suspended matter, iron, or any other impurity which would tend to form a deposit on the zeolite grains and thus interfere with the free exchange of the bases must be removed from the water before it is passed through the softener.

Until the last few years, the use of this method was confined largely to the industrial field. Municipal plants of this type, however, are now in operation at Sewickley, Pa., (9) Bellevue, Pa., (10) Mangum, Okla., (11) and elsewhere.

Lime-Zeolite Method

Studies made in Columbus in 1926 (12) indicated that carbonate hardness could be removed more economically by lime treatment than by base exchange, while the cost of removing non-carbonate hardness by the zeolite process was only one-half that of soda ash treatment. By removing the carbonate hardness with lime and effecting the remainder of the softening by base exchange, therefore, the advantages of both methods can be economically incorporated in one treatment plant. The advantage of the zeolite method of being able to effect any desired degree of softening can be retained without the inherent disadvantage of producing a water containing a high content of sodium salts.

The plant recently constructed at Findlay, Ohio (13), is operated on this principle. The raw water has a carbonate hardness of about 300 p.p.m. and a non-carbonate hardness of approximately 200 p.p.m. The former is reduced by lime treatment and recarbonation to about 40 p.p.m., and then sufficient of this water is passed through zeolite softeners to maintain a final hardness of about 100 p.p.m. in the treated water.

COST OF WATER SOFTENING

Owing to the number of factors involved, it is rather difficult to generalize in regard to the cost of water softening, particularly with respect to capital costs. The construction cost depends on the method to be employed and on whether the plant is to be an entirely new installation or simply an addition to an existing purification plant. The Manual of Water Works Practice (p. 261) states that the cost of a lime-soda softening and filtration plant is approximately $40,000 per million U.S. gallons and about one-half that amount if filtration through sand is eliminated. The Lincoln, Kansas, works (13-A), which consist of an iron removal, lime-soda softening and filtration plant with a capacity of 288,000 U.S. gallons per day, was constructed by force account at a cost of less than $7,500. The cost of the Mangum, Okla., plant (11), which is a 1-million U.S. per day zeolite installation, was $45,500.

The cost of operation depends on the method to be employed, whether the addition of softening facilities would involve the employment of additional labour, the carbonate and non-carbonate hardness of the water to be treated, and the degree of softening required. Hoover (12) reported that the average costs of lime for carbonate hardness removal and of soda ash for non-carbonate hardness removal at Columbus in 1925 were 5.7 cents and 12.5 cents per p.p.m. per million U.S. gallons, respectively, while the cost of salt for regeneration of the zeolite softeners at McKees Rocks, Pa., (0.315 lb. per 1,000 grains of hardness removed) was 6.2 cents. In similar terms, Montgomery (5) stated that the chemical cost of ordinary lime treatment at Piqua is 4 cents, the cost the additional softening effected by the excess lime and recarbonation process 2.5 cents, and the cost of soda ash treatment 12 cents.

These cost data show that if removal of the carbonate hardness alone will effect the desired degree of softening, the cost will be considerably lower than if non-carbonate hardness must also be removed. In the latter case, employment of excess lime treatment, recarbonation and sludge return will reduce the amount of soda ash required and, therefore, the total cost of softening.

In some cases, the additional softening effected by this method as compared with ordinary lime treatment would render the use of soda ash unnecessary. Where the non-carbonate hardness is high, the zeolite or lime-zeolite processes should be considered, depending upon whether or not carbonate hardness is also present in an appreciable amount. This would involve a study to determine the economic balance between the construction and operating costs of the different methods, taking into consideration also the advantages and disadvantages of the various processes.

Soap Waste

Hardness manifests itself to the water consumer chiefly in the amount of soap which must be used with it before the cleansing power of the soap becomes effective. This soap-consuming power of a water, as it is termed, increases more or less directly with its hardness, and is employed in the laboratory as an approximate measure of total hardness. The consumption or loss of soap is due to the alkali of the soap molecule being replaced by calcium or magnesium in the water, forming calcium or magnesium soaps, which, being insoluble, are deposited. The collection of these insoluble soaps in the form of curds on the sides of washbasins, etc., although not always recognized as such, is familiar to all. Sufficient soap must be added to precipitate all the hardness in this way before a lather can be obtained. It is evident, therefore, that the soap is really being employed as a softening reagent. This is a very expensive method of softening, as one pound of lime costing about 0.5 cents will soften as much water as 20 pounds of soap costing 2 to 3 dollars (14).

Prof. A. M. Buswell (15) shows that the theoretical soap loss is about 1/20 pound of soap per 1,000 gallons for every part per million of hardness, and that laundry experience indicates a loss of about twice this amount. He estimates that a ton of soap is wasted every day in a community of 40,000 people using a water with 300 p.p.m. of hardness.

Miss Pauline Snyder (16), in Columbus, made direct observations on the amount of soap used by a family of five when using softened and unsoftened Scioto River water. The total hardness of the former was 80 p.p.m. and of the latter 270 p.p.m. She found that approximately 11.46 pounds of soap were used during a week when the hard water was employed, while only 3.7 pounds were consumed during a similar period with the softened water, equivalent to a saving of 403.5 pounds of soap per year. On the basis of these observations, it is estimated that this consumer could afford to pay five or six times as much for the softened as for the unsoftened water from the standpoint of soap saving alone. These data, expressed in the terms employed by Buswell, represent a soap waste of approximately 1/7 pound per 1,000 gallons per part per million of hardness.

Miss Snyder's observations also indicated that the time required to launder clothes was 50 per cent greater with the unsoftened water than with the

softened water, and that clothes washed in the latter were cleaner. Other observers have drawn attention to the benefits arising from the use of soft water for laundering: Strout (17), for instance, reports that clothes washed in soft water have an increased life of 25 to 100 per cent.

Most authorities consider that the saving in soap alone is greater than the cost of municipal softening. Thus, at Lansing, Michigan, Eldridge (18) estimates that the annual soap loss is $134,000, while the cost of softening would be only $103,300, and at Madison, Wisconsin, White (19) estimates the soap waste to be $67,890 per annum and the cost of softening at only $38,225. Similarly, McNamee (20), in Fort Wayne, Indiana, where it is proposed to soften the new water supply from the St. Joseph River, estimates that soap consumption will be reduced from $6 to $1 per capita per year, while the cost of softening, including fixed charges, will be only $1 per capita per year. Again, at St. Louis, Missouri (21), the cost of softening in 1930-1 was $110,438.94, while the saving in soap effected thereby was estimated at in excess of $550,000.

Similar quotations from the literature could be cited at great length, but those given demonstrate that soap waste constitutes an economic loss of great magnitude.

Other Effects of Hard Water

Another effect of hard water, which, although less readily apparent to the domestic consumer, is nevertheless of great importance, is the increased fuel consumption due to the formation of scale on the heating surfaces of boilers. Parr (22) states that a conservative estimate of the loss of fuel would be 10 per cent for each 1/16-inch of scale, while Rankine (23) estimates the loss at from 16 per cent for 1/6-inch of scale to 150 per cent for 1/2-inch.

The importance of proper conditioning of boiler feed water is now universally recognized. Many of the larger installations are equipped with elaborate plants for correcting scale formation, corrosion, and other effects associated with unsuitable feed waters; and even in the smaller plants, boiler compounds, etc., are employed for preventing and removing scale. Although municipal water works could not be expected to supply water which would meet the exacting requirements of modern high pressure steam power plants, reducing the hardness of the municipal supply to the point considered satisfactory from the standpoint of other uses would be found of considerable benefit in the operation of all hot water systems, great or small.

In the industrial field, also, the value of a soft water supply is becoming increasingly apparent. Thus it has been observed that hard water causes loss of dyes in the textile industry, waste of tannins and other chemicals in tanning operations, toughening of canned vegetables, and increased use of size in paper manufacture. It also gives rise to unsightly cores in artificially-frozen ice cakes and introduces complications in the scouring of textile fibres.

That manufacturers are realizing more and more the importance of the

quality of the water supply in connection with various industrial operations is indicated by the ever increasing frequency with which enquiries are received for a statement of the analysis of the municipal water supply, particularly when a site is being selected for the location of a new factory. In this connection, data given by Hoover (24) regarding a study of the growth in population of 10 Illinois cities are of interest. The water supplies of two of the cities are excessively hard, while those of the other eight are comparatively soft. In 1880, the two "hard water" cities had 26 per cent of the total population of the ten cities, while in 1920 this percentage had dropped to 13.7, in spite of other natural advantages. These figures are very significant.

Some years ago, goitre and certain diseases of the kidneys were attributed by investigators to the domestic use of hard water, but it is now generally conceded that, within reasonable limits, there is little connection between the hardness of the water supply and the health of the community (25, 26).

Desirable Degree of Hardness

The degree of hardness implied by the rather vague terms "hard" and "soft" water is materially different in various parts of the world. Thus, Aquilar and Ocampo (27) in discussing the artesian waters of Manila and vicinity describe them as soft—that is, usually below 230 p.p.m.,—while, in marked contrast, Mason (28) states that, in the United States, waters containing 50 p.p.m. of hardness or less are considered soft and those containing 100 p.p.m. or more are described as hard. Similarly, Baylis (29) has expressed the opinion that it would be economical to soften every water supply with a hardness in excess of 100 p.p.m., and in many cases also when the hardness is less than this amount.

The trend of opinion in the United States is indicated in a statement by Hoover in 1927 (30) to the effect that all municipalities which had installed purification plants during the previous five years had included provisions for softening when the raw water hardness exceeded 150 p.p.m.

Where softening is employed, it is the usual practice to reduce the hardness to a value in the neighbourhood of 75-85 p.p.m., although at some plants the treated water has a hardness of about 100 p.p.m. In Columbus, considerable dissatisfaction existed during the war period when the hardness was reduced only to 100-120 p.p.m. (31), but the consumers appear to be satisfied when the delivered water has a hardness of 85-90 p.p.m., as at the present time. At several recently constructed plants, the hardness is reduced to 50-60 p.p.m., and at one plant at least, Boca Raton, Florida (32), to 44 p.p.m.

As water softening becomes more widely practised and the value of a soft water more generally appreciated, it is probable that a water considered satisfactory from the standpoint of hardness at the present time may not be so considered at some future period.

Canadian Conditions

At the present time there is not a single municipal water softening plant

in operation in Canada (33)*. This is rather curious, in view of the fact that one of the first water softening works on this continent was constructed in Winnipeg over 30 years ago (34). The Winnipeg plant, which had a capacity of 2.4 million gallons per day, is of interest not only on account of its being one of the earliest, but also because of the fact that the softened water was recarbonated prior to filtration. The results reported would indicate also that excess lime treatment was employed, as it does not seem possible that such efficiency could be obtained by any other means. The plant consisted of lime dosing equipment, upward-flow settling tanks, carbonating equipment and 7 filters. The latter, from the description of their operation, appear to have been filter presses. The present water supply of Winnipeg, derived from Shoal Lake, has a total hardness of 90 p.p.m. (35) and is not subjected to any treatment except chlorination.

That the absence of softening plants in Canada is not due to a prevalence of soft water supplies is indicated by the following data compiled from a list of Ontario water supplies (36) for which information is available:

Total Hardness	*Number of Supplies*
Less than 50 p.p.m.	29
Between 50 and 100 p.p.m.	29
Between 100 and 150 p.p.m.	43
Between 150 and 200 p.p.m.	18
Between 200 and 300 p.p.m.	55
Between 300 and 400 p.p.m.	19
Over 400 p.p.m.	11

Insofar as this province is concerned, therefore, softening would be beneficial in a number of municipalities, and the same is true, no doubt, throughout the Dominion.

This state of affairs, however, is by no means confined to Canada, Buswell (37) having estimated in 1930 that not over 10 per cent of the water supplies which, from an economic standpoint, should be softened, are softened. He states further that, while every public water supply in the state of Illinois should be softened, only 1 per cent of the municipal water works are equipped for softening.

The majority of the communities included in the above tabulation, of course, have relatively small populations, but that this is not necessarily a hindrance to successful application of water softening is indicated by practice in Ohio, where only 11 of the 38 municipal water softening plants in operation are in communities with populations greater than 10,000. Four of the towns where softening is practised have populations of less than 1,000, and one, Le Roy, has only 241 inhabitants. Ohio, however, is exceptional with respect to water softening, nearly 30 per cent of the 140 municipal plants in the United States being located in this one state. This remarkable progress is undoubtedly

*Since this paper was presented, a zeolite softening plant of 1.5 m.g.d. capacity has been constructed and placed in operation in the township of Etobicoke, Ontario.

due, in no small measure, to the influence of C. P. Hoover, who has probably contributed more to the science of water softening than any other man on this continent.

The apparent backwardness of many municipalities in not taking advantage of the now fully understood methods of improving their water supplies with respect to hardness, notwithstanding the attendant economic loss to the community, is undoubtedly largely due to a seemingly natural tendency to avoid treatment processes which involve somewhat complicated chemical reactions, necessitating technical control. Adequate control, of course, is a problem in small centres of population, but this difficulty has been solved in Ohio (39) by chemists from the larger municipalities acting as supervisors of the plants in the smaller communities nearby.

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The Treatment of the Paralyses of Poliomyelitis

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Part I---The General Principles

EACH epidemic of poliomyelitis leaves in its wake a number of potential cripples, whose future presents an economic problem. It is not a problem, however, in which we look in vain for a solution. The lessons taught by accumulated experience to men who have studied the behaviour of paralyzed muscles since the days of Charles Fayette Taylor seventy years ago, lighten the course to follow —a course long and tedious and often beset with difficulties; yet one which, if followed with unswerving allegiance, will guide many patients to complete recovery and almost all to economic usefulness. In general, the child who survives an attack of paralysis has an expectation of life as long as his unaffected brother. If his respiratory and abdominal muscles have escaped, or recover, he may live for sixty or even eighty years after the onset of his paralysis. The accident of this disease will not reduce the number of his days; but his usefulness, his independence and his happiness over the years, depend upon two factors:

1. The degree and extent of the destruction of the anterior horn cells of the spinal cord; and
2. The perfection of the detail of the care which is given him from the hour of the onset of his paralysis.

PATHOLOGY AND PHYSIOLOGY

If poliomyelitis in the human equalled in the severity of its lesions, the disease produced in the monkey by the intra-cerebral inoculation of an adapted virus, the first factor would be the more important; the second, less; but poliomyelitis, as it is occurring at present, throughout the civilized world, does not tend to cause death of all the neurones in any part of the cord. The microscopic pathology is characterized by the patchy distribution of the damaged cells. While vascular changes may be general throughout the cord, and cell destruction most intense in some localities, even in these some anterior horn cells usually escape. The clearing up of the inflammatory process has advanced by the end of five weeks, and is usually completed by the end of eight weeks from the onset of paralysis. Unlike encephalitis lethargica, no focus is left to smoulder and light up again after years of quiescence; nor will any process of strangling of surviving cells by scar tissue occur, for the scars are neuroglial only. Usually, the degree and extent of paralysis which exists dur-

ing the first week from the onset is greater than it will be at any other period. The tendency, thereafter, is towards recovery. If one hundred per cent of the motor cells innervating all the fibres of any muscle group had been destroyed, one could not anticipate any recovery; but, because the essential lesion is patchy in its distribution, and because a percentage of cells usually survive, the prognosis for recovery is better, and therefore the responsibility is greater for the provision of the opportunity for the natural processes of recovery to proceed to their limit.

In an early paper of Lovett's appears the advice to any physician caring for patients to ask himself the following questions: (1) What are you trying to do? (2) Is it worth doing? and (3) Are you doing it? Considering the answer to the first question, we cannot restore to life the cells which have died. We can do little, if anything, to hasten the natural tendency to recovery, in the affected spinal cord; but we can, by taking care of the muscles, innervated by surviving cells, by shielding them from additional injury, give the survivors the opportunity to take over the work which before the lesion they shared with the cells which the lesion has destroyed. We know that, just as there are more glomerular units in the kidneys than are called into simultaneous action during health, so most people rarely use, at any one time, all the fibres of any muscle group. Each individual fibre, when it contracts, contracts to its utmost; but all are not called into action unless the effort demands them. As expressed by Wood Jones,[1] "muscles go full steam on half boilers, not half steam on all boilers." Development of the "reserve fibres" is obvious when a person takes up labour involving repeatedly, maximum efforts, as is seen in the development of the hand muscles of milkers, and of the shoulder and back muscles of wharf labourers. Labourers do not begin life equipped with a greater number of neurones, or of bigger and better muscle fibres, than do the children who will later become clerks; but, by repeated stimulation, they fully develop muscle fibres which, in other people, function less frequently. Because of the provision of more neuromuscular units than are usually required in health, when some of the cells innervating any muscle are destroyed by poliomyelitis, unless the proportion is high, the survivors may be adequate to take over the function of the units destroyed by the lesion, and normal function of the muscles be restored. They cannot do this if further handicaps be added. Unfortunately, in uncared-for cases, even after minor degrees of paralysis have occurred, two factors will operate to handicap the natural processes of recovery: (1) fatigue of the neuromuscular unit; and (2) stretching of surviving muscle fibres.

Stretching of Weakened Muscles

Even normal muscle fibres, when continually stretched, lose temporarily their contractile power.[4] The effect of extension is greater on muscles partially paralyzed; and, as stated by Taylor, a slight degree of continuous or comparatively sudden extension, which may be harmless in a healthy muscle, may be capable of destroying the feeble irritability and power of

a muscle partially paralyzed. Appreciation of this fact, that functional disability will be added to the result of the lesions of the disease, if affected muscles are continually stretched, is fundamental to the treatment of cases of poliomyelitis; and conversely, that if a muscle is to have the opportunity of achieving the maximum recovery of which it is capable, the bones on which it acts should be placed in such a position that the muscle will be continually relaxed. This principle was emphasized in the writings of Taylor in 1866, was taught by his contemporary in England, Hugh Owen Thomas,[2] and has been the life-long teaching of Sir Robert Jones. To quote from Taylor's[3] book: "This relative losing or gaining of force corresponds exactly, in all cases, with the position of the muscles, whether they have been kept in extension or relaxation; for muscles allowed to relax—all other things being equal—gain as much as the extended ones lose. The muscles kept in a shortened position recover irritability more readily than if kept extended to their natural length, but, having no extension, become in time inelastic and tendonous; while those kept unnaturally extended lose their irritability and become thin and degenerated. And having thus destroyed the harmonious action of the muscles, as well as their length and mechanical adaptation, we have the first elements of a deformity." These facts, while acting harmfully in neglected cases, give us guidance for the treatment of both early and neglected cases of poliomyelitis. At the onset of paralysis, when it is too early to decide which muscles have been most affected, we can favour, by relaxation, the muscles of greatest economic importance to the individual. Later, when the pathological processes in the cord have been completed, it is usually possible to determine which muscles require the advantage of relaxation more than their antagonists.

DEVELOPMENT OF DEFORMITY

In neglected cases, gravity exerts its force in allowing certain positions to be continually assumed; well-meaning, but ignorant nursing favours relaxation of certain muscles at the expense of their antagonists. The tension of muscles relatively stronger results in mechanical shortening when their attachments are approximated for long periods. The less the degree of paralysis, the more readily do the favoured muscles assume the permanently shortened condition. Thus, deformities develop, due to the lack of protection from antagonistic forces. The second basic principle in the treatment of the paralyses of poliomyelitis is, therefore, that *deformities are not essential sequelae of the disease, but, in every instance, are preventable.* When they are allowed to occur, the process of recovery is arrested. Consider the sequence of events in a patient who has had a generalized involvement of the muscles of the trunk and limbs. At the onset, all the muscles may be equally affected, but all the neurones to any group may not have been destroyed. His parents may have heard that "rest" is the treatment for paralyzed cases, and they interpret this as meaning rest in a comfortable bed. Gravity induces outward rotation of both thighs, thus favouring the out-

ward rotator muscles, and handicapping further the internal rotators of the hips. By its action, dropping of the fore part of the foot is induced, thus stretching the dorsi-flexor muscles of the ankle joint, and relaxing the flexor muscles of the toes. Because it is almost a routine with nurses, a pillow will be placed under the knees, and so the hamstrings will be helped, the quadriceps insulted; while, by the same position, the flexors of both hips will be relaxed, the hip extensors stretched. Later, as his general health improves, he will be propped up in his soft bed by two or three pillows, thus flexing the hips further, stretching the gluteal muscles to a greater degree, and stretching the spinal muscles. His trunk will assume haphazard positions as he slips down on his pillows. As everything of interest in the room is usually on one side, to that side he will face, perhaps supported by pillows. In this way, the lateral abdominal muscles of one side will be favoured by relaxation, at the expense of the stretching of the muscles of the other side. The iliac crest of one side will approximate to the costal margin above it. Bowed by the yielding bed and the pillows placed behind his head and shoulders, the costal angle will narrow, the ribs assume a more vertical course and the chest expansion will progressively diminish. As poliomyelitis has its maximum incidence in children in the growing period, when the bony structures are still soft, the slightest deviation or rotation of the spine to one side will be accentuated as growth occurs, for "as the twig is bent, so is the tree inclined." Thus will develop the most terrible of all deformities—scoliosis following poliomyelitis, with its interference in stature, in chest expansion, in resistance to respiratory disease, and with its promise of pain in later life, when, as the intercostal spaces of one side become crowded, the intercostal nerves will be compressed.

Because it is a natural position, and warmer, his arms will be kept in bed, adducted and internally rotated at the shoulders, flexed at the elbows and pronated. Thus, the adductors and internal rotators of the shoulders will be favoured, and will recover power and shorten to contractures; while the deltoids and the outward rotators of the shoulders have their chance of recovery jeopardized by the additional handicap of prolonged stretching. At the elbow, the brachialis will have the optimum chance of recovery and the triceps will be damaged further. Later, when the patient becomes restive, he will be lifted into a chair, perhaps a wheel chair, and the disastrous process of handicapping further essential muscles will proceed more quickly, for the influence of gravity is stronger. The weight of the unsupported arms will stretch further the deltoid muscles; the sitting position will stretch the gluteal and quadriceps muscles even more, while favouring their opponents. Thus will be hastened the development of the commonest contractions, flexion of the hips and knees. The weight of the abdominal viscera will stretch the abdominal muscles which will share with the spinal muscles the responsibility for his later scoliosis. Later, when he wants to move about, he will find that he has grown to the shape of his chair, and the only method of progression

left to him is like that of an animal, on all fours. The manufacture of the actual cripple from the potential cripple left by the disease, has been completed. His deformities should not be attributed to the original lesions, but to the circumstances which favoured some muscles and further handicapped others. If the balance between the muscle groups be kept from the onset, the hip extensors, the quadriceps, the spinal and abdominal muscles, the deltoid and the outward rotators of the shoulders, the triceps will have an equal opportunity of recovery; for the changes in the cord towards recovery proceed evenly, irrespective of whether the muscles which the neurones supply are favoured by relaxation, or further handicapped by stretching forces. Consider the different sequence in this patient, if care be taken to give the first opportunity of recovery to the muscles essential to the maintenance of the erect position; if the same care which a gardener gives to a weakly sapling, is available to secure him, while recumbent, in such a position that, when rotated through 90 degrees, his shape will always be that of a normal erect human of good posture, instead of the shape of a chair. If such care be given him from the onset, until the muscles have recovered to the maximum, no deformities will develop; the muscles, nurtured so carefully, may recover completely; and even if the initial damage has been so severe that braces will be necessary, after the muscles have recovered to their limit, the braces can be fitted to straight limbs, and preliminary operations to correct deformities will be unnecessary.

It is possible to retrace the steps which produced the cripple from the person wounded by the lesions of poliomyelitis. Muscles wait patiently and store their capacity to recover, if, by some chance, the opportunity ever comes. A patient neglected, allowed to drift into deformities, when discovered, can be helped; but his treatment must aim first to bring him back to the place from which he should not have been allowed to diverge, where the treatment of his paralysis must begin. In neglected cases, continual relaxation of muscles, assumed to be completely paralyzed, will in many instances be followed by recovery of power. Many examples have been reported in the writings of Sir Robert Jones.[4] "A boy of ten was seen after arthrodesis of the knee had been performed, because of paralysis of the quadriceps extensor, of three years' duration. The operation was a failure, because the knee moved, but the interesting fact was that the quadriceps, so long rested, had recovered, and the knee could be strongly and easily extended." In 1903, Tubby[5] and Jones reported a series of cases who had come to them, because of paralysis of the dorsi-flexors of the wrist, of durations varying from three to twenty-two years from the onset of paralysis. In these patients, complete recovery of function occurred when the wrists were steadily maintained in the position of hyper-extension for a period up to twelve months. Such examples of recovery, when muscles are favoured by relaxation, even years after the onset, are frequently seen. They teach the lesson that, given the same favourable opportunity at the onset, muscles will recover earlier.

SPLINTING

Many parents know from experience in other illnesses that foot drop should be prevented and splints applied to hold the feet in dorsi-flexion. While this may be a wise provision at the onset, it may be obvious some weeks later that the dorsi-flexors are stronger than the muscles of the calf, when the relative power of each group is tested against gravity and against resistance. The splinting, therefore, should be modified to favour the calf muscles by holding the foot in plantar flexion, care being taken that the ankle, and not the fore part of the foot is flexed. The calf muscles are more valuable to the patient than the dorsi-flexors, and in health their task is greater. Therefore, when both groups are affected, it is wiser to favour the calf muscles first, for they have the greater distance to retrace to normal power. The normal quadriceps is a stronger muscle than the normal hamstrings, and more essential to the maintenance of the erect position; therefore, splinting should hold the knees in the normal position of extension until the quadriceps has recovered to a degree that it is able to extend the knee against gravity and some resistance, when tested with the patient recumbent and the hips flexed. At that stage, it is safe to favour the hamstrings by cautiously increasing the degree of flexion given by the splints. The hip extensors, the glutei maximumi, are the most important muscles in holding the body erect. They are used in rising from a chair and in going up stairs. Their recovery means more to the patient than does that of any other muscle of the lower limbs. Given normal buttocks and normal calf muscles, many patients with little power in any of the other muscles of the lower limbs are able to walk without supports. The hip abductors are more valuable than the adductors, for the permanent loss, even of one group, results in an ugly disabling dip in the walk, and swinging of the trunk towards the affected side with every step. For these reasons, at the onset of paralysis it is wiser to favour by relaxation, the hip extensors, the abductors and the internal rotators, until their recovery has reached a stage at which it is safe to allow slight flexion, less abduction and less internal rotation of the hips.

In the upper limb, the deltoid is the muscle whose recovery is most difficult. The shoulders, therefore, should be held in the position of abduction until its recovery is assured. The optimum degree of rotation of the shoulders may be determined from week to week by the examination of the relative strength of the muscles carrying out the movements of internal and external rotation. At the onset of paralysis, both groups may be affected equally and a neutral position is the best. In cases seen even one week from the onset, the internal rotators, from their relaxation, are usually relatively stronger, while the external rotators have been stretched and have lost in power. The optimum position, in such cases, should be one of external rotation of the shoulders, until a later examination has shown that they have recovered more than the internal rotators. Then the position should be modified again. At the elbow, the flexors are the more valuable group, but, when the patient is

in bed, and no splinting is carried out, they are favoured by the position of the arm. The triceps is a muscle of great importance to a man whose later work will demand the effort of raising weights above the level of his head, as in pitching sheaves on to a haystack, or throwing out fleeces. Consideration of the probable future demands of his work will similarly influence the decision whether to aim, first, at recovery of the supinator muscles or the pronators. The dorsiflexors of the wrist and the muscles involved in opposition of the thumb are so important, in every person, that care should be taken to give them, by continued relaxation, the first opportunity of recovery.

Because of the varying conditions, as power returns to some muscles more quickly than to others, one cannot treat cases of poliomyelitis as cases of surgical tuberculosis are treated: by fixation in a frame for long periods, without modification of the position. In the first year the splinting requires modification at frequent intervals, to ward off any incipient deformity, and to keep the balance of power in the favour of the muscles whose recovery will help the patient most. Because this process is slow, because surviving neuromuscular units may require months or years to take over the work of their dead colleagues, the splints will need frequent adjustment as the patient grows. The youngest patient treated in Melbourne, last year, was five weeks old when paralysis occurred, and every fortnight her frame had to be lengthened as she grew. A frame which fits accurately at the time of application will become a powerful deforming agent nine months later, unless adjusted as the child grows.

Just as diabetic patients can be taught the details of their treatment, so, even children learn which are the muscles to be cherished. Last year, I lifted a boy of nine years out of his frame. He was heavy, and I was awkward, and, for a moment, I allowed his right knee to flex. The right quadriceps had been paralyzed eighteen months before. Geoff turned to me with amazement and concern, and said, "Doctor, how can you expect me to make that quadriceps, when you let the leg drop like that? The quadriceps will take at least a week to forgive that stretch." He had learned the first principle of the art of caring for his muscle; and he appreciated that the details of that care must be perfect, if the muscle was to be given its chance of recovery. Parents learn to take pride in the way a child is secured in the frame. They must realize that the frame possesses no mystic healing powers, and that it is the manner in which it is applied, by day and night, which determines whether the results will be success or failure.

AUXILIARY METHODS OF TREATMENT

Warmth, saline baths, muscle re-education

Consider the question, "What are we trying to do by these methods?"

Warmth increases the circulation in the limbs, and thus hastens the recovery of affected muscles. Parents should be taught the importance of protecting the paralyzed limbs from cold. The growth of limbs is influenced by their temperature. Experi-

ence in Victoria has shown that, when care is taken over long periods to protect affected limbs from cold, disparities in length between normal and paralyzed limbs do not occur to the degree seen when one limb is normal and active, and the other paralyzed limb, held in a brace, is cold during all the waking hours. Prevention of gross inequalities of growth has justified the trouble taken to maintain an even temperature. Bed boots and covers for the splinted arms, made of coarse knitted wool, or material lined with fur, should be made long enough to extend over most of the thighs and of the upper arms. Radiant heat can be given inexpensively, by means of a square metal cradle whose upper surface is covered with a sheet of asbestos, a lamp with a carbon filament being attached to the under surface.

Saline Baths:—Soon after the onset of paralysis, daily immersion in a warm bath of hypertonic saline is valuable in alleviating tenderness. Patients look forward to the time spent in the bath. Later, while in the saline, the patient may be allowed to carry out gentle movements. The support given by the hypertonic saline makes movements easier than in air, and thus the movements induce less fatigue. Such gentle movements lessen any tendency to limitation of the range of joint movements. Details of various methods and of precautions to be taken, will be given in Part 2.

Muscle Re-education:—By this is meant the art of coaxing any surviving muscle fibres to bring about a limited number of contractions of the muscle: to guide the patient, by mental concentration, to send messages from his cortex to surviving neurones which, before the lesion occurred, may not have been accustomed to functioning together, but which can learn to do so. "Parts that have functioned together, tend to function together more easily again." When a partially paralyzed muscle contracts, it not only improves the nourishment of its fibres, but also the co-ordination of the neurones which supply it, provided that the contractions be not continued long enough to induce fatigue. Muscle re-education requires, on the part of the person undertaking the work, an accurate knowledge of anatomy and of the action of muscles, if she is not to be deceived by "trick" movements; that is, by movements carried out by the contraction of normal muscles, and not by the paralyzed muscles. Trick movements when allowed by a parent or physiotherapeutist, imperfectly trained, are dangerous. They are responsible for the development of many deformities. For example, if a child lying on his back on a smooth surface be asked to abduct the thigh, if the abductors are too weak to overcome the friction, while moving the limb from the adducted to the abducted position, he will bring about what he considers the same result by contracting the lateral abdominal muscles of the same side, thus hitching the pelvis on that side nearer to the costal margin. If this habit is not corrected, the lateral abdominal muscles of that side, which, having escaped paralysis, do not require the stimulation of further exercise, will increase in strength and an asymmetry of the trunk will commence and lead on to scoliosis. The physiotherapeutist should appreciate

the influence of gravity, in grading degrees of paralysis, and in planning exercises adapted to the varying requirements of the muscles she is trying to nurture to recovery. She must be able to record accurately the grades of paralysis in individual muscles, according to the standard adopted in the community in which she works. In some centres five grades of paralysis are used for record purposes, in others nine. A muscle is graded as normal when able to contract for the same period without fatigue, against gravity and added resistance equal to that of the same muscle in a normal person of the same age and equivalent muscular development. The standards of one system are as follows:

Grade 1, good, when the muscle is able to act against gravity and some resistance.

Grade 2, fair, when the muscle is able to carry out its action against gravity alone.

Grade 3, poor, when the muscle is able to bring about all or part of the normal arc of movement, but is unable to carry out the movement against gravity.

Grade 4, trace, when no movement is possible, but, on attempted movement, the tendon can be felt to tighten.

Grade 5, absent, when no response can be felt in the tendon on attempted movement.

In the centres where nine grades are measured, the varying degrees of paralysis between fair (Grade 2) and normal are measured, and recorded with greater accuracy.

The physiotherapeutist should be alert to recognize the first evidence of actual shortening of any muscle, to prevent its contracture and deformity. She should appreciate the principles of posture, in order to hold her patient in good position, while recumbent, and later, to guide him to the best way of carrying his body weight. The equipment she requires is simple; several pillows, a tin of powder, and one or two pieces of three-ply wood. A convenient size is three feet by two feet six inches, prepared with rounded corners, smooth edges and one side slightly polished and smoothed by sand papering. By adjustment of the pillows, on which the board is placed, the physiotherapeutist is able to vary the inclination of its plane and thus adapt each exercise to the capacity of the muscle, at each stage of recovery. When given by an expert, who has served a long apprenticeship in its exacting art, muscle re-education is of the greatest value. *Its place, however, in the treatment of paralysis, should be regarded as auxiliary, and subsidiary to measures taken to ensure the fundamentals,* — relaxation of affected muscles and their protection from fatigue. Economic factors frequently make daily expert treatment impossible. When the patient has been trained for several weeks, it may be possible to compromise, by teaching the parent to carry out a number of simple, relatively safe exercises, under supervision at weekly intervals. At her visits the physiotherapeutist will detect and correct any trick movements, and determine whether the parent, in her anxiety to accomplish, has lost by inducing fatigue.

EXERCISES UNDER WATER

In some centres, where numbers of patients are gathered for treatment,

large pools for giving exercises under water have been installed. These are valuable at a late stage of the treatment, when all the muscles have reached the grade of good or normal, when the exercise in water bridges the gap between exercises while recumbent, and exercises with weight bearing. In another group of cases, severely paralyzed by the initial lesion, exercises under water serve to develop muscles unaffected by the disease. In early cases, however, the use of a pool demands a staff thoroughly alert to trick movements, and in numbers large enough to ensure that no harm is done to the weakened muscles by stretching, even during five minutes while the patient is waiting to enter the bath, or to be replaced in his splint afterwards. Care should be taken, while one limb is having exercise, that the others are not allowed to assume positions which will injure muscles which the treatment aims at helping. Though of definite value psychologically, it is unlikely that anything is gained by partially paralyzed muscles given exercises under water which cannot be achieved by exercises provided with the simple equipment of a table, a smooth board, a tin of powder, and several pillows, by a physiotherapeutist who knows her work.

FATIGUE

It is interesting, in the writings of men who have spent their lives in caring for these cases, to trace how, as their experience deepened, they came to appreciate the damaging influence of fatigue, and to learn how cautiously exercises and the use of affected muscles should be increased. Taylor,[3] in 1866, expressed his conclusions so clearly that they merit quotation. "*Recuperative Period.* Here we arrive at a very critical period. A certain amount of recovery has taken place with a corresponding amount of improvement in some at least of the muscles. How shall we keep up this recuperative process? Every organ is strengthened by the proper use of its function. Whatever power there may be in a muscle, after a certain time, needs to be used in order to develop more. But there may not be enough for the purposes of locomotion or actual use. Evidently, then, we must contrive to afford the muscles opportunity to act *within their capacity,* alike avoiding inactivity or over action, until their development has reached the point where they are capable of being made available in sustaining the weight of the body and in locomotion. We must furnish the muscle an exercise that shall not exceed its capacity, and not till the powers of the muscles have been developed till they are equal to sustaining the weight of the body, should they be required to sustain it. There is no physiological principle more clear and simple. The legs of a paralyzed child in relation to its body may be compared to those of an infant called upon to support the trunk of a man. They cannot do it and they should not be allowed to attempt it until they have grown equal to their load."

WEIGHT BEARING

In Lovett's earlier publications, he advised that, when the lower limbs had been involved, braces should be fitted as soon as possible and the

patients put on their feet. In 1916,[6] the more accurate measurements of the spring balance test, and the observation of the rapid recovery which occurred when paralytics, previously ambulatory, had been kept recumbent, and splinted for a period by the accident of some other affection—such as synovitis of the knee—led him to appreciate the danger of fatigue induced by weight bearing, even with braces. His education was carried further by observation of a group of cases whom he kept from walking during the first year. In this way, he "became familiar with a character of result which previously he had not known existed." He admitted in 1917[7] that "no one was more skeptical than I of the treatment by prolonged recumbency. I have become a thorough convert to the practice, not only in recent cases, but in old cases where it is desired to secure the maximum of muscular development. I believe that an appreciably weakened muscle can be given all it should do by being given therapeutic exercises without weight bearing; and I think, moreover, one should be exceedingly careful not to overdo this. I believe that, when the muscles of the trunk and lower limbs are involved, the number of cases in which recovery is to be obtained, is very greatly extended by keeping the patients from walking during the first year, and in many cases during the second year also." Experience in Australia has taught me the truth of these conclusions, and has led me to carry them even further,—*that no arbitrary time limit can be set to the process of recovery in partially paralyzed muscles*; that muscles have no cognizance of calendar months. The factor which determines the degree of power to which a muscle may attain, given favourable conditions, is the degree of the initial damage, the percentage of cells surviving, not the passing of the first or second anniversary. A muscle which is improving during the first and second year, will, if favourable conditions be continued, achieve some more recovery in its third. I cannot yet say whether recovery continues longer than six or seven years, but the improvement to complete recovery in some muscles, and to the grade of good in the remainder, from the grades of poor and trace, in one patient, who has been kept carefully splinted in recumbency, while having re-education since December, 1925, has taught me that, in some cases, given the opportunity, the process may be continued for at least six years. Recovery does not occur evenly, but rather as a series of spurts and slower periods, more in the summer, when heliotherapy can be given, than in the winter months. The patient referred to achieved more recovery in the third year than in the first. Therefore, it seems logical to "rope it all in," before deciding to be satisfied with an incomplete result and allowing the patient to stand and walk.

The patients may be divided into three groups. The mild cases will recover completely, before twelve or eighteen months have elapsed. They may then be allowed weight bearing exercises, carefully controlled and gradually extended, until full liberty is allowed through all the waking hours. Watch should be kept for any evidence of fatigue, which will show as a reversion to a trick movement

or a slight limp. Its appearance means that the muscles, while able to carry out ten or twenty contractions perfectly, are not yet ready for the tasks the patient's will dictates for a longer period; nor are they strong enough to withstand the steady pull of muscles still relatively stronger. Frequently, in the earlier years in Victoria, we were taught by disappointments the necessity of hastening slowly, of allowing the muscles time to develop strength, and not to set them tasks for longer periods than their optimum. It is interesting to note that the same lesson has been taught to those caring for patients with involvement of the respiratory muscles, by means of machines carrying out artificial respiration for long periods. As recovery occurs, the patient may be able to breathe for himself for a short period. This period out of the respirator must be increased very gradually. If allowed out of the respirator for a period longer than the optimum, the power returning to the respiratory muscles will disappear and will not return to the same degree, until the muscles, by a period of complete rest, have had a chance to recover from the damage of overstimulation. In all cases which have been shepherded through the various stages of recovery, it is wise to retain the use of the splints at night for a period after recovery seems complete.

In the second group, after twelve months' careful treatment it may be obvious that the initial damage has been so intense that no recovery has occurred; that it is not justifiable to continue longer. These patients should be fitted with appliances, and taught to walk as best they can; but make certain, before deciding that a muscle is hopeless, that, by constant protection, it has been given every chance.

In the third group are the cases who have gradually recovered some power during the first year, and this improvement has continued during the second; yet, by the end of the second year, recovery is not complete. It will be asked, "Why not let him up, perhaps with braces or with a slight limp?" Each patient is an individual problem for study. If the paralysis be localized to a region for which operative orthopaedics has some good alternative to offer, then it may not be justifiable to keep a patient tied to a frame for years. This applies particularly to paralysis involving the muscles of the feet, in which operations have much to offer. When paralysis involves such muscles as those of the buttocks or the quadriceps, in which operative orthopaedics, while able to improve the function in neglected or hopeless cases, cannot offer function comparable to that of a normal muscle, surely it is sound policy to continue the regime until, by the absence of improvement for a period of six months, it may be assumed that the natural process of recovery has attained its limit. Experience has led me to regard the routine fitting of braces to allow walking at the end of any arbitrary period, equivalent to signing a document condemning into braces, often for life, patients whose muscles may have potentialities of complete recovery, if given further opportunity. It is not difficult to obtain the co-operation of parents for prolonged recumbent treatment, if the alternatives be ex-

plained to them clearly, and the responsibility placed upon them. For example, suppose a patient is a girl of six years, paralyzed two years before, the paralysis affecting one lower limb. In the two years, the muscles of the feet have recovered, and the buttock muscles and quadriceps have advanced from the grade of poor to almost good. The parents—usually the father—become restive, and ask about allowing her to walk. At the rate her muscles have improved during the second year, there is reason to think that they have in them, if nurtured further, the potentialities of complete recovery. If she is allowed up at this stage, a brace will be necessary, and she will almost certainly need that brace for the remaining years of her life. She may acquire a trick balance, and walk without a brace, with hyperextended knee, while the limb becomes the shape of a banana. If kept recumbent, she need miss nothing essential. She is having education by post, and, with her mother's help, has kept up with other children of her age in all subjects, and has passed them in some. She can be carried about easily in her frame, and is happy. Let them think well before deciding to give up the excellent chance of complete recovery, the reward for another one or two years of patience, for the alternative of condemning their child to the handicap of a brace for sixty years or to an unsightly deformity. When they have seen other patients who have slowly recovered, and have had the opportunity to realize what a cross a brace for life, or a distorted limb, can be to a sensitive woman, the parents educated in the principles of insurance, will usually decide to go further before saying "content."

COMPROMISE

In adults, the necessity of earning a livelihood often introduces difficulties in arranging for prolonged splinting in recumbency. Efforts should be made to overcome the difficulties, for the recovery rate in adults is usually much faster than in children apparently equally affected by the lesion. At least, try to arrange that the most valuable muscles are given a chance, the buttock muscles, the quadriceps, the muscles of the trunk, and the deltoid and the opposing muscles of the thumb. If, however, circumstances deny the patient the chance to shield his weakened muscles from one noxious influence, fatigue, it is usually possible to protect them from the other, the stretching of paralyzed muscles. If the lower limbs be involved, he should be fitted with braces, to hold them in the best position by day. At night he should continue to sleep in the frame. When the quadriceps is involved in such a patient, the brace fitted should not be jointed at the knee. If constantly protected from stretching, the muscle may gain slowly, and the patient postpone the attempt to achieve more recovery until a more convenient time. One good result of the economic depression in Melbourne has been that several young adults, who could not give up the time for rest soon after their onset, lost their employment, and have used their enforced leisure to provide the optimum chance of recovery to affected muscles. In such cases, where fatigue has arrested the process of recovery, more improvement will occur if an initial period of several weeks of complete rest precedes any re-education.

Braces play an important part in

the rehabilitation of severely paralyzed patients. They should not be regarded as part of the treatment of paralysis, but as appliances to reinforce the power of limbs unequal to the support of the body weight, and as day splints to prevent deformity. When it is probable that a brace for the leg will be required through life, that no more recovery in the quadriceps is to be hoped for, then the extra comfort of a joint at the knee may be given to a patient old enough to justify the additional expense. In children, braces require readjustment periodically. When the muscles, given every opportunity, cannot completely recover, or when circumstances deny the opportunity, then operative orthopaedics will often be able to carry the rehabilitation further. An operation, wisely selected and wisely timed and followed by careful after-treatment, may restore a useful degree of function. Consideration of the selection of cases for operation comes outside the scope of a paper dealing with the treatment of the paralysis.

RESULTS

I have tried to answer the first of the questions: "What are we trying to do?" and to indicate, in outline, the method which I believe to be the way of doing it. The second question demands an answer. "Is it worth doing?" At the onset, because of the uncertainty of the prognosis, it is incumbent upon us to give every patient an opportunity. For those severely hurt by the disease, we must do the best we can. If one lower limb is so badly paralyzed that little or no recovery will occur, the care of partially paralyzed muscles of the trunk or other leg may do much to lessen his ultimate handicap. If, after all the care, he has to wear a brace for life on one limb, the recovery of the other will improve his gait. If deformities have been prevented, the fitting of the boot and brace is simpler, while the recovery of trunk muscles will save him from the extra handicap of a scoliosis, a spinal fixation, or a permanent support.

Even if this group, in which permanent paralysis remains, which cannot be saved from actual crippling, provides 15 per cent of the total, it is worth the trouble to save the remainder. In Victoria, since 1925, the co-operation of parents, gifted with mechanical sense, and a horror of crippling, has given an exceptional opportunity to apply faithfully the simple basic principles. Complete recovery has occurred so often, after months and years of patient treatment, that we are no longer elated by it; but saddened by the residuum whom the disease has hurt so badly that some crippling is inevitable, though rehabilitation is usually possible. We may have been fortunate in that the type of disease occurring has caused widespread vascular changes, with the death of a percentage of cells rather than intense and localized lesions; but clinically the degree and distribution of paralysis at the onset resembled that seen in recent cases in America and England, this year. We know that the cases of generalized incidence and moderate severity are the very cases who develop the grossest deformities, if uncared for. This is the day of preventive medicine. We have not yet available any prophylaxis against

poliomyelitis, but we have, if we will apply principles which have been known for seventy years, exact knowledge of the means to guide a large proportion of its victims to complete recovery, and to save almost all of the remainder from the life-long crippling which too many are apt to accept as inevitable.

SUMMARY

1. Each epidemic of poliomyelitis leaves behind it a number of potential cripples.
2. The damage done by the disease reaches its maximum within a short time of the onset. Thereafter, in the majority, the tendency is toward full recovery of function.
3. This natural process is handicapped by the noxious influence of two factors which commence to operate *after* the initial lesions and are determined by circumstances. These factors are:
   (1) Lengthening of partially paralyzed muscles and the development of contractures, and
   (2) Fatigue.
4. These factors are entirely preventable; but, if allowed to act, they will arrest the tendency towards recovery, and manufacture actual cripples from the persons wounded by the disease.
5. The proportion of cases so severely damaged by the initial lesions that their ultimate crippling can fairly be attributed to the disease, is relatively small.
6. The added handicap of the two damaging forces can be prevented by a regime of accurate splinting in recumbency.
7. The microscopic pathology of the disease in the human is characterized by the patchy distribution of destroyed cells.
8. In normal persons, more neuromuscular units are provided than are often called into action simultaneously. When a proportion has been destroyed by the lesions of poliomyelitis, unless the proportion is high, the survivors may be adequate to carry out the tasks of the damaged cells, and normal function be restored.
9. Auxiliary measures to improve the nutrition of surviving muscle fibres are warmth and immersion in warm saline.
10. The nutrition of surviving muscle fibres, and the co-ordination between their neurones is improved by muscle re-education, which is the science of stimulating surviving muscle fibres by voluntary contraction within the limit of their capacity.
11. Muscle re-education is an exact science and should be undertaken only by those trained in its principles and its technique, and who appreciate its potential dangers.
12. If the maximum of recovery is the aim, the regime should be continued as long as recovery is occurring.
13. By the end of the first year, it is usually possible to determine

which are the cases whose cells have been so severely damaged by the initial lesion that further efforts to achieve recovery are likely to be unavailing.

14. For such patients, if the limbs and trunk cannot bear the body weight without assuming a position of deformity, braces and supports should be accurately fitted and the patient retain the use of the frames at night.

15. Appliances need periodical supervision and adjustment.

16. In some cases, the process of recovery will continue for many years, if the conditions favourable for recovery of muscles be continued.

17. When recovery has occurred, the transition from therapeutic exercises to weight-bearing should be gradually accomplished. Fatigue is still a potential danger.

18. When economic conditions prevent the attainment of the ideal of prolonged protection in recumbency, combined with muscle re-education, it is worth while to accept a compromise, and, at least, prevent deformity.

19. The success of the treatment depends upon the perfection of the detail of the application of fundamental principles, and therefore demands frequent and prolonged supervision.

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Part II---Some Details of the Management of Early Cases

IMPROVISED SPLINTING

ADULTS. The limbs and trunk of an adult or older child may be held in good position by simple contrivances. To simplify description, assume that the paralysis is generalized. Place boards transversely under the mattress, as for a fracture bed. They will be more satisfactory if joined together. To hold the feet in the optimum position, make removable splints, extending to the middle of the

thighs, the knees being extended. These may be made of plaster of paris, wood, stiff cardboard, or wire outlines with material. The splints should not cause hyperextension of the knee, and the limbs should rest in them comfortably. In order to anchor the limbs in these splints, place under them both, transversely, at the level of the calves, a strong wooden plank. At the optimum distance of each limb from the other, cut slots through the plank, wide enough to take a securing webbing band. Grips of spring metal may be attached instead of webbing to ensure the required degree of abduction and rotation of the hips. Even when paralysis affects the proximal muscles of one lower limb only, it is wise to anchor both limbs and the pelvis, to prevent the patient from rolling on to his side in sleep.

The abdominal muscles are involved in at least 70 per cent. of all paralyzed cases. For these and patients with paralysis of the spinal muscles, a well fitting coutil corset should be made. An elastic gusset, inserted into the upper third of each side, allows for chest expansion. This function is favoured by the support afforded to the lower abdomen. The corset should fit firmly, to prevent stretching of the abdominal muscles. When only a part of the abdominal wall is involved, a band of stitched material should be attached to the outside of the corset to reinforce its support to the weakened area. The corset must be long enough to grip the pelvis. Webbing straps may be attached thereto and secured to fixed points on either side of the bed to keep the patient straight.

Upper Limbs. Nail a piece of wood, four inches wide, to each end of the board placed under the mattress, at the level of the shoulders. Each of these pieces should be longer than the patient's forearm and hand, and be secured at right angles to the plane of the bed, so that their broad surfaces face each other. Bandaging each forearm to this vertical piece will hold the shoulders in abduction, mid-rotation and midway between flexion and extension, while the elbows will rest in mid-flexion, the fore-arms being supine. When the patient's upper arms are too long for the width of the bed, or if weakness of a triceps demands more extension of the elbow, make a removable splint for each arm to secure the optimum position of elbows and wrists, using plaster of paris or metal. Their attachment to the bed or to out-riggers therefrom will rest the shoulders in the position which the condition of the muscles dictates. In the hand, the muscles most commonly affected are the intrinsic muscles of the thumb, and the interossei and lumbricales. Stretching of these induces loss of normal opposition and hyperextension of the metacarpo-phalangeal joints and flexion of the inter-phalangeal joints of the fingers. If neglected, the deformities described as the "ape hand" result. In no other muscles does more recovery occur than in the intrinsic muscles of the hands, when the affected muscles are nurtured by constant relaxation. Splints made of papier mâché, moulded to each hand's requirements, are a convenient method of anticipating this deformity. By these contrivances it is possible to hold an adult in good position, the corset anchoring the trunk, its attachments to the bed limiting rotation of the spine and efforts to sit up; the splints

applied to the limbs caring for the distal muscles, and the fixation of these splints controlling the position of the hips and shoulders. These positions should be modified as the condition of the muscles demands.

Children

(2) It is more satisfactory, instead of fitting several splints to one child, to fit the child to one splint. A child will try to wriggle out of separate splints, or to crawl or roll, dragging the splinted limb after him. Experience with Australian children has taught me the futility of asking a child to maintain any one position, unless restricted. It is instinctive for him to try to sit up and twist around, if he can contrive to do so. Much argument is avoided, if, at the onset, when his tenderness makes him grateful for the comfort of its support, he becomes accustomed to the restrictions of a frame. In isolated communities, where it is often difficult to have a frame made of metal, or to obtain one from measurements sent away, an effective substitute can be made by any carpenter. Select a smooth plank of wood one inch to one and one-half inches thick, longer than the child, and as wide as the required angle of hip abduction demands. Place him on it. Mark the position of the buttocks and the occiput, the places for attachment of leather grips, to secure the pelvis, and of webbing straps, to secure the chest and shoulders, and of straps to secure the lower limbs at the lower third of the calves. Remove him and carve from the wood, bevelling the edges, hollows in which the buttocks and head will rest. It may be possible to remove a triangular piece of wood between the lower limbs, to facilitate nursing. The feet must be cared for by additional removable splints, made of plaster of paris or of metal. These should be secured to the frame by clamps, or webbing bands passed through slots cut in the plank. A covered strip of saddler's felt, one inch thick, should be applied to the frame where the head, back and thighs will rest, with an additional pad under the knees, and a thinner layer under the buttocks. A carpenter will be able to attach outriggers, to hold the upper limbs in the optimum position. Though too heavy to be carried from place to place, such wooden frames can be made to carry out essentials of splinting. It is interesting to learn that the Indian woman of Canada used a frame very similar to the one described, as a cradle for her papoose. In Victoria, an adaptable metal frame has gradually been evolved by modification of the double Thomas splint. A detailed description will be published shortly. When the lower limbs are normal or recover before the upper limbs, a common practice is to allow the child to walk, protecting the deltoid by an abduction splint. This practice is not without its dangers, unless the trunk muscles are beyond suspicion, and the abduction splint is fitted, and frequently readjusted to hold its purchase of the pelvis. Unless these conditions can be fulfilled, in order to avoid a scoliosis, it is often safer to keep a child recumbent straight in his frame, retaining the upper limb in its attachment.

BATHS

Children

(1) A saline bath may be given each day, soon after the temperature

has subsided. A handful of crude salt to a large bath-tub half full of water gives a solution of suitable strength. When the child is tender and resents handling, it is wise to place him on a light wooden tray, and lift the tray into the saline, which should cover his lower limbs. Later, when his tenderness has gone, the head and pelvis may be supported by slings, suspended from each side of the bath. If the deltoids be paralyzed, the upper limbs should be maintained in the abducted position, by slings from the top of the bath, or by padded blocks of wood placed between the arms and the trunk. Before being trusted to give her child a bath, the mother should fully appreciate the necessity of holding the limbs in the optimum position for the recovery of affected muscles, during the preparations for the bath and after it has been completed. A child should not be left unattended while in the water. If care is taken, the time spent in the saline may be gradually extended to as long as one hour, if the patient, immediately or in his exercises later in the day, shows no signs of fatigue.

Adults

(2) With heavy children and adults, it is possible to immerse the body in saline, while the patient remains in his bed. If there be no necessity to keep the shoulders abducted, the bath may be managed by the use of bolsters and a large sheet of water-proof, as in the "gutter bath" of typhoid patients. When shoulder abduction is essential, a modification of this method may be used, by applying fences to three sides of the bed. On each side, to the ends of the boards placed transversely under the mattress, secure, by means of hinges, a plank two feet high and as long as the bed. Attach hooks to the lower ends of these two side fences, to be fastened securely to a similar fence secured to the foot of the bed. The fourth wall of the enclosure is provided by two large, firm pillows, stuffed with some cheap material. One of these is placed above each shoulder and fitted closely to the patient's neck. The patient is wrapped in a thin blanket. The large sheet of water-proof material is passed under him, and, by means of clothes-pegs, its borders are secured to the upper edges of the lateral and caudal fences. The cranial border of the water-proof is passed over the pillows above his shoulders, and secured to the top of the bed. Warm saline is poured into the enclosure until the lower limbs are covered. The temperature is maintained by additions when required.

Removal

The removal of the saline is simplified if a small trap door has been inserted in one of the lateral fences. When this is withdrawn, some of the waterproof material may be cautiously taken through the opening to form a funnel. It may be difficult to remove the last of the saline if the mattress sags in the centre. An additional plank placed longitudinally under the mattress will overcome this difficulty.

GENERAL MANAGEMENT

Heliotherapy is helpful, if it can be provided without exposing the limbs to cold. The diet should provide

necessary vitamins. The parents should be warned against over-feeding and the type of food which will tend to increase the patient's weight. Marked increase of weight above his normal will handicap further his weakened muscles. Involvement of respiratory muscles demands the same protection from fatigue. Appliances which provide this and are able to carry out artificial respiration for long periods, are available only at certain hospitals.

In conclusion, obtain the co-operation of the patient and his parents for the long period of care required. Persuade them to forget the question, "How long will it take?" and concentrate on the other question, "How far towards complete recovery can we take him?"

Part III---Some Organizations to Provide this Care

THE first part of this article has stressed the fact that the crippling which follows poliomyelitis is, in the majority of cases, not caused directly by the damage of the disease, but by circumstances which operate after the disease has done its worst, and that these circumstances can be controlled. The opportunity presented has been recognized in many countries; but in others, equally sympathetic with the actual cripple, it has not yet been appreciated how much more profitable it is to deal with the potential cripple; how much better results will follow, if the work be undertaken at the time most favourable, before the damaging forces have had the opportunity to add their handicap: before deformities have developed, before muscles striving to recover, have been flogged to complete paralysis by fatigue. Few parents can afford to bear, unaided, the cost of expert treatment required over so long a period; yet, while economic pressure accounts for some neglected cases, ignorance and apathy account for more. Even in centres where facilities are available and free, some cases will be hidden, until discovered later when deformities have developed. In country districts the problem is more serious. If the parents are intelligent and anxious to help the child, they take him to their doctor, who, in an isolated district, is handicapped by lack of facilities for obtaining suitable splints; nor can he arrange for muscle re-education. Moreover, during his student days, the absence of an epidemic may have deprived him of the opportunity to learn the detailed care required; and in the medical curricula of many countries, instruction in the art of conservative orthopaedics is crowded out by the time devoted to instruction in the treatment of acute disease.

If the opportunity for recovery is to be given to every case, its provision must depend, wholly or in part, upon organizations supported by charitable or community funds. These may not be adequate, even if the parents do their utmost, to attain the ideal of splinting in recumbency and expert muscle re-education, for every patient over the long period required. Lack

of money may force the choice between the provision of ideal treatment to a small percentage, and complete neglect of the remainder, or a compromise: to arrange that, by less frequent supervision of some cases, every one will be afforded, at least, the opportunity for some recovery, and that none will be allowed, by neglect, to drift into deformity. Each country must seek a solution for its own particular problem—the solution depending on the funds available, the temperament of its people, the number of potential cripples which epidemics of poliomyelitis contribute annually to the general cripple population; and the instruction in conservative orthopaedics, given to its practitioners, either as students or post-graduates.

ENGLAND. THE NATIONAL SCHEME

In England, though sporadic cases occur each year, epidemics of poliomyelitis are infrequent, and the care of affected cases is included in the wider schemes which aim at the prevention of crippling in general; at the treatment and rehabilitation of the eighty to one hundred thousand crippled persons in England, and of the five thousand added each year, if care is not available. In England, poliomyelitis does not present a problem of the same magnitude as it does in countries in which epidemics are more frequent, and the incidence of other crippling diseases, such as rickets, is less. Nevertheless, the unique opportunities of salvage have been appreciated by those responsible for the various schemes in England—schemes which have developed from the vision and the example of Agnes Hunt and Emily Goodford at Baschurch thirty years ago. From that Shropshire farm, and from its successor, the Shropshire Orthopaedic Hospital, has gone out a band of trained people, stimulated by the example and the wisdom of the pioneer plan, realizing, from its demonstration, all that can be done, within the limits of present knowledge, to solve the cripple problem. These men and women have founded, in other parts of England, similar schemes to prevent crippling by education, to undertake the care of the potential cripple, and the treatment and rehabilitation of the actual cripple, within the area of a certain number of counties. So the map of England is gradually being covered with zones of cared-for areas. Each zone has its centre at an orthopaedic hospital and training school where the rehabilitation of actual cripples is carried out. In the early days it was realized that an orthopaedic hospital alone is no solution to the problem. Its influence operates after the best opportunity has passed, and its work is incomplete unless its patients are cared for after their discharge. The potential cripple must be found and cared for at an earlier stage, and the patient whom the hospital has helped must be supervised for years. There is only one way to do this—to bring facilities to the patient, to his home or county town or village, by clinics, at regular frequent intervals, and by means of a staff of trained workers, to guide the care of the patient in his home. In England, each of these clinics is called an "After-care Clinic"; but, in many, after-care is a small part of their function. Prevention of crippling

provides the greater part of their work. This was clearly demonstrated in the contrast between the type of patient seen in counties where clinics have been in operation for years and those seen in counties where clinics have recently been opened. In the former, some of the patients attending came from their work for periodical supervision. The remainder were potential cripples—suspect or early cases of surgical tuberculosis, manifestations of mild rickets, defective posture, early cases of poliomyelitis. The years of work and of education of the people in these counties have been effective in making the best of the actual cripples found when the scheme commenced, and in stopping at its origin the manufacture of a further supply. In some Welsh counties, where the work is only commencing, the type of patient predominating was the wheel chair cripple, distorted and helpless.

The expense of establishing such units—orthopaedic hospitals, after-care centres, the workshops for training severely handicapped patients,—has been borne by voluntary organizations or by individuals or by public subscription. The cost of maintenance of indigent patients, throughout the various phases, is recovered from community funds—from the Ministry of Education for the maintenance of children, from the Ministry of Health for tuberculosis cases, and from local government bodies, such as the board of guardians, for the remainder. Over one hundred detachments of the Voluntary Aids of the British Red Cross assist in the administration of the after-care clinics.

Consider the facilities offered by such a scheme to patients paralyzed by poliomyelitis. The doctor may refer the patient to the central hospital; or the patient be brought to a clinic near his home; or the after-care sister, at her visit to the village twice a week, obtains his name from the list of notifications, or hears about him from another patient, or voluntary worker. She drives to his home, to ensure that he is receiving treatment. By one means or another, he is discovered and usually brought to the hospital for the initial treatment. The network of protection must be fine enough to guarantee that none will slip through the holes of ignorance, apathy and poverty into deformity. The patient is kept in hospital until his muscles, by careful nurture, have been given opportunity to attain their maximum; then taken home, to attend the nearest after-care clinic, or be visited in his home by the sister and by the doctor at his monthly or bi-monthly visit, until his recovery or his rehabilitation is complete. It may not be possible to keep him as an in-patient for as long a period as recumbent treatment is required. If the parents are able to co-operate, they are taught to carry out the care at home, under frequent supervision. Later, if appliances are required, they are made at the hospital work-shops to tracings taken at the clinic near his home, and are fitted there, where he is supervised indefinitely.

The pioneer plan at Shropshire extends over four Welsh and four English counties—from Chester on the north to Herefordshire on the south, from the Welsh coast to the potteries on the east, where another scheme takes over, organized from

Stoke-on-Trent. The number of clinics established from this central hospital is over thirty. The after-care sisters have been trained by a four-year course, as orthopaedic nurses and physiotherapeutists at the central hospital.

VERMONT

The Vermont plan was initiated after the epidemic of 1914. Details are given in a separate article. The years have demonstrated how good are the results obtained, when care is taken to avoid the additional handicap of deformity, even though regular muscle re-education by experts cannot be provided.

CHICAGO

In Chicago, after the epidemic of 1916, the Visiting Nurse Association of Chicago assigned certain of its nurses for systematic instruction, to equip them for follow-up work in the homes, of the cases left by the epidemic. This has developed into a special division of the Association, at first devoted entirely to poliomyelitis cases; later, expanded to care for orthopaedic cases in general. Nurses who, after graduation, have served for at least one year in the general work of the Association, are selected for a further two-year period of training in physiotherapy and muscle re-education. The staff of the orthopaedic division at present, with its supervisor and her assistant, numbers twenty-one. New cases of poliomyelitis are reported to the Association by the Health Department. The nurse makes a home visit while the patient is still in hospital. She explains the regime of his after-care, answers the questions of the parents, and stresses the importance of continuous supervision by his doctor. The hospital notifies the Association when the patient is discharged, and, if his doctor is willing to have the co-operation of the nurse, she will instruct the parents in the details of his management. When the time has arrived to begin re-education, the nurse visits the home three or five times each week, and, as time goes on, the mother is gradually given more responsibility, and the visits of the nurse are reduced to one or two each week. This care is continued until the patient has recovered, or until he is allowed up, perhaps fitted with braces. Then he is referred to one of the special schools for crippled children, where supervision and physiotherapy are continued, while his education proceeds. All this time, the nurse has co-operated with the family doctor; or, if the parents cannot afford a private doctor, the patient is referred by the nurse to the orthopaedic hospital nearest to his home. The nurses of the Association, while able to carry out the expert muscle re-education, save the doctors the tedium of the detailed instruction of the mothers. This Association is a voluntary body.

AUSTRALIA

In Melbourne, a similar plan was evolved to take care of cases in the out-lying suburbs, and of patients in the city too heavy to be carried to the out-patient department of the hospitals for their treatment. The salaries of the itinerant staff, and the expenses of their care, have been paid by a special grant from the Victorian

Government to the Children's Hospital, which since 1925 has been struggling to provide ideal treatment for most of the indigent cases of the state under the age of sixteen. The majority have been referred by their doctors for treatment. Smaller children, or those who lived nearer to the hospital or near a convenient railroad have been carried to the hospital daily by one of their parents, either in a street car or wheeled from the railway station in a long pram. The provision of prams has been simplified by converting old baby carriages to accommodate the frames. The father usually does the alteration.

As far as possible, country cases have been gathered into groups of six to ten at a base hospital to which a trained physiotherapeutist is attached. The expense of appliances and their repairs is borne by the hospital, and by parents, with or without assistance from small charitable funds. An almoner has been appointed by the Junior Red Cross to help in the necessary organization. One of her duties is to endeavour to see that no paralyzed patient is neglected. If the parents in the city fail to bring the child regularly, she visits the home, and usually, impressed by her explanation and heartened by the interest taken in their child, they decide to continue. We have learned that better results are obtained when the parents have to shoulder their responsibilities early. The usual stay in hospital, for city cases, is ten days. During an epidemic, the demand for beds may make it even less. Help has been given to doctors in isolated districts by having frames and appliances made in Melbourne to measurements and tracings of the patient. The Education Department has co-operated by arranging for postal education. The splints required are made at the hospital work-shops by a splint maker who, himself, demonstrates the results of prolonged recumbency. Paralyzed at the age of one year, he was kept from walking for seven years by Dr. Batten of Great Ormond Street in London. The staff, who carry out the details of the treatment, are women who have obtained the Diploma of Massage of the University of Melbourne, after two years of study. During that period, they dissect the cadaver twice, and are expected to equal, in the standard of their knowledge of anatomy of the limbs, muscles and nerves, the standard of medical students. It was found that, when sent to country districts, the doctors expected the physiotherapeutists to carry out details of the improvised splinting required. For these requirements and the detailed technique of muscle re-education, they were imperfectly equipped. Therefore, some years ago, a post-graduate course of twelve months was commenced; and the staff, to whom the care of the cases is entrusted, is selected from those who have had this additional year of training. The scheme is far from complete. It is probable that some country cases have been missed entirely. For other country cases and young adults, economic reasons prevented adequate treatment. For these, the compromise was accepted, and the parents taught to care for the patient at home, and at least, prevent deformity. We regretted the compromise, for several reasons. We appreciated the handicap of even

minor degrees of crippling in Australia, where the attitude to cripples is different from that of older countries.

Results which would be looked upon as good in England and America, are regarded with sorrow and aversion in Victoria. The lack of industries in which the partially disabled may be placed, may partially explain this attitude.

A further stimulus to arrange for the best opportunity possible, instead of accepting a compromise, results from the Invalid Pensions Act. Years ago, a law was passed to grant to anyone who could not work through invalidity or disablement, the sum of one pound per week from the age of sixteen until death. This has been generously interpreted and persons have been granted pensions when, for example, paralyzed in both lower limbs, even though able to walk with braces. So the type of patient who, had he lived at Shropshire in England, would have been taught and placed in trade, has drifted through life, idle, receiving his weekly dole. The annual payments to the cripples left by the small epidemics of 1898, 1908, and 1918 have been 18,000 pounds. The epidemics which have visited Australia yearly since 1925, causing 1,500 cases, have swollen the ranks of the potential pensioners. The sum paid as pension to a boy paralyzed at the age of sixteen, amounts to £2,600—$13,000—if he lives to 66 years. Thus, the economic wastage is brought home more forcibly in Australia than in countries where this system does not exist. When an epidemic occurred in Tasmania, in 1930, the opportunity to save the Federal Government great expenditure was appreciated. Three months later, the Tasmanian Government decided to provide treatment for the indigent survivors. Country cases were cared for in base hospitals, and city cases in their homes. Splints were made by carpenters or engineers; muscle re-education was carried out by four physiotherapeutists sent over from the mainland. Though, in several cases, a compromise had to be accepted, the results after nine months treatment of 54 cases in the Hobart district were reported as follows: "May, 1931. Twenty-three, normal; nineteen practically normal. Some will have, if treatment ceases now, permanent slight disability with no deformity. Nine will require apparatus to aid walking, though no deformity. Three remain potential invalid pensioners. A most conservative estimate of the number saved from becoming invalid pensioners is 15, an ultimate saving to the Commonwealth of £34,100, or $170,000." The Tasmanian Government, on receipt of this report, decided to continue the provision of care.

SWEDEN

For many years the importance of the care of the potential cripple has been appreciated in Sweden. While as far back as the eighties, a beginning was made by charitable institutions to care for the cripple and establish him in industry, special circumstances necessitated the transition from this purely charitable work into one of the most important branches of social work. The severest epidemic of poliomyelitis which has ever befallen a small country occurred in Sweden in

1911 and 1912. In the course of a few years over 14,000 cases were reported. In 1914 the legislation for invalid pensions came into force. It was soon realized that provision of pensions without preventive nursing was inadequate; that prophylactic and curative treatment was imperative. The laws relating to poor law relief and the care of children have been efficient in providing the best treatment even to the poorest, even if ignorant parents or guardians have tried to prevent treatment. Financial assistance has been given to previously existing charitable institutions and the state has established others. The example which the Swedish scheme contributes is the intimate connection between the various aids for the prevention and care of cripples on the one hand, with the general provision of medical relief throughout the country on the other. It has been realized that institutions for the care of these cases should be established as part of general hospitals and the material there be used for clinical instruction. The combination of public and private work has been very satisfactory. Most of the institutions are governed by private association and financed by contributions from the State, the county or the parish. Even the vast, sparsely populated Norrlandian district is included. No distinction is made, as in many countries, between the child and adult. A central council co-ordinates all phases of the work.

NEW YORK STATE

In New York State, a comprehensive scheme has been evolved since 1916, though it has been merged into the wider scheme of provision of treatment for cripples in general. The State Government employs four part-time orthopaedic surgeons, and 22 itinerant nurse-physiotherapeutists. Clinics are held at regular frequent intervals, and, as far as possible, the patients are cared for, under supervision, in their homes. The Education Department, by its net-work of visiting teachers, special schools, transport to normal schools, ensures synchronous education. The State Department of Rehabilitation carries the work a step further by fitting the patient into industry.

CANADA

After the epidemic of 1927 in Alberta, the Provincial Government built a hospital of 60 beds to provide treatment for the paralyzed cases. Efforts have been made to continue, after discharge, the supervision necessary to complete the work of the hospital. In the maritime provinces, large epidemics of poliomyelitis have not occurred recently; but it is estimated that one-fifth of the cripple population has had poliomyelitis. The problem there presented, brought to light by the work of the Red Cross, is the different one of making the best of the actual cripple. By the co-operation of the Red Cross and the Rotarians with Dr. T. Acker, clinics have been held since 1924 in Nova Scotia, Prince Edward Island and Newfoundland. The ground work is ready, should another epidemic occur. There, as in other parts of Canada, the co-operation of voluntary bodies with orthopaedic surgeons is doing splendid work in the "making over" of the actual cripple. Toronto has

demonstrated that it is possible to check at its source, the stream of cripples from bovine tuberculosis. Closer co-operation, further organization, will enable Canada to eliminate from her cities and remote country districts the cripple from poliomyelitis of the type which leaves one wondering, like King Edward, "If preventable, why not prevented?"

Infantile Paralysis in Vermont

LILLIAN E. KRON, R.N.

Director, After-Care for Infantile Paralysis, State Department of Public Health, Burlington, Vermont.

THE history of poliomyelitis in Vermont dates back to 1894, when the first epidemic of considerable size in the United States occurred. The epidemic was reported by Dr. Charles S. Caverly, President of the State Board of Health. The second epidemic occurred in 1910, when seventy-two cases were reported and the disease was made notifiable in the State. In 1911, twenty-seven cases were reported, and in 1912, thirteen. The toll was higher in 1913, the number of cases reported being forty-seven. The year 1914 is a memorable one in the history of infantile paralysis in Vermont, for three hundred and six cases were reported, fifty-three of which were fatal. In the same year, research and after-care became established as part of the State health program. Local doctors were at a loss as to what to do for their patients. Dr. Caverly realized the necessity of attempting to prevent recurrences of such epidemics and also for the prevention of deformities and disability in those already stricken. As a result of Dr. Caverly's efforts, a sum of money was given anonymously for this work by a generous and interested citizen of the State. So it happened that Vermont became the first state to organize a plan for the after-care of poliomyelitis cases. Dr. Simon Flexner, of the Rockefeller Institute of Medical Research, was called upon by the Board for suggestions to use this gift to the best advantage. His suggestions were carried out in the following manner:

1. An educational campaign was conducted by Dr. Francis R. Fraser, Dr. Robert W. Lovett and Dr. Harold Amoss. Meetings were held in five centres in the State to arouse the medical profession to the importance of the disease and to give them the best advice available.
2. A laboratory was established at Burlington, in the College of Medicine of the University of Vermont. Under the direction of Dr. Amoss, Dr. Edward Taylor carried out original research in various phases of poliomyelitis until 1919, which Dr. W. Lloyd Aycock continued until 1931.
3. Dr. Robert Lovett, the Professor of Orthopaedic Surgery at Harv-

ard Medical School, was in charge of the after-care. The great number of cases prevented the attempt to see the patients, individually, in their homes or in doctors' offices. Plans were made to hold clinics in the following centres: Burlington, Barton, Montpelier, Rutland, and St. Albans. The physicians of the new cases had been notified in advance, and they passed the good news on to their patients. Whenever possible, the patient was examined in his doctor's presence. Treatment, consisting of restricted activity, muscle training, massage, and braces, was prescribed by Dr. Lovett, and instruction in the detail of the care was given to parents by his assistant, Miss W. Wright.

A second series of clinics was held in July, 1915, at the same centres, by Dr. Lovett and his assistants. Although the patients who had followed the treatment prescribed at the previous clinics showed decided improvement, it was evident that better results would be attained if home treatment could be supervised by a field worker. To do this, Miss Janet B. Merrill remained in the State for two months following the clinics. Train service was inadequate; so, unfortunately, the work had to be limited to those living in or near a railroad centre. This work was continued the following year, when clinics were held biweekly in the larger centres. In this way closer supervision was given to the cases who could be brought to her.

In 1917, a severe epidemic occurred, and as demands for assistance increased, it was decided to employ two full-time field workers. Clinics were again held by Dr. Lovett in August, assisted by the field workers. With the out-break of the war, the staff was depleted and one field worker bore the burden alone until the summer of 1918. From that time until May, 1919, there was no infantile paralysis after-care work in the State. During the interval, requests were continually received at the State Board of Health for advice and assistance; braces needed repairs or were outgrown; old deformities were increasing; new ones were developing; and new cases needed examination and advice. The work was resumed in May, 1919, with the appointment of two field workers. A great deal of work had accumulated, and patients were discouraged because of the interruption and the uncertainty of the continuation of their care worried them or their parents. Home visits were made and patients were advised to attend Dr. Lovett's clinics which were scheduled for July in the usual five centres and St. Johnsbury. The result was gratifying, as four hundred and eighteen cases reported for examination.

Since 1919, the work has been carried on without interruption following the general plan which has become widely known as the "Vermont plan." Since the death of Dr. Lovett, in 1924, the annual summer clinics have been conducted by Dr. Ober and his assistants in nine centres where fall and spring clinics are held by the two field workers. Surgical treatment has been necessary in many cases. Some patients have been enabled to discard braces and jackets after operations to stabilize joints, or transplant muscles; while other cases, whose only means of progression was on their hands and knees, have been "straightened out"

and are now walking with the aid of braces and crutches.

Most of the surgical cases have gone to hospitals in Boston and New York and to the Shriner's Hospital in Springfield, Massachusetts. Hospital fees and the expenses of appliances have been paid, wholly or in part, from the fund for those patients whose parents could not bear the long continued treatment which is often necessary.

In 1921, through the generosity of another citizen of the State, a school and home for eighteen paralyzed children was opened at Proctor. The patients derived considerable benefit from the regular treatment they received, while education was proceeding. Unfortunately, this school had to be discontinued in 1929.

Not only do the adult patients require physical care, but it soon became evident that a worker was required to guide them in some occupation to make them partially or wholly self-supporting. A department of vocational training was established in 1921. Handcrafts were taught to the patients and the articles made were sold at shops and at women's clubs, summer hotels, etc. This work proved to be of decided value, not only financially, but psychologically.

The present staff of workers in the state consists of two nurses, who have had special training for this type of work, the vocational teacher and a secretary. The following figures have been taken from the last annual report:

Number of patients on records under supervision January 1, 1931	1,202
Number of patients examined at clinics	917
Number of home visits made by the two field workers	1,197
Number of admissions to hospital	59
Number of new pieces of apparatus supplied	324
Number of pieces of apparatus altered or repaired	129
Number of orthopaedic corrections made to shoes	371
Number of patients discharged during the year	252
Number of patients on record January 1, 1932	950

Vermont has been fortunate in having men like Dr. Caverly and Dr. Lovett as founders of this work; in having such a generous and interested citizen to finance it during the past eighteen years; and at the present time, in having a man like Dr. Ober generously contributing his services as a surgeon and advising as to the best method of treatment for the patients.

CORRECTION

In Dr. Ronald Gwatkin's paper, *Antigenic Qualities of a Dissociated Strain of Brucella Abortus*, which appeared in the October issue of the JOURNAL, the second last paragraph on page 492 should read as follows:

"One liver agar slant of *R* injected by the intra-abdominal route failed to protect guinea-pigs against infection by mouth and eye with the *S* type three and four weeks later. There was no difference between the vaccinated and control groups judged by the criteria of serum titres, lesions, cultures and weights."

Editorials

THE POLIOMYELITIS PROBLEM

EXPERIENCE with diphtheria must teach us lessons applicable to the problems presented by other diseases. Especially is this so in regard to poliomyelitis. The value of antitoxin in treating diphtheria has been, for many years, so thoroughly established that there remains no doubt whatever of its efficiency. But to control the problem of diphtheria, toxoid for active immunization was an absolute and urgent necessity. Antitoxin, as it was used throughout Canada, had not by any means conquered diphtheria, which remained the chief cause of death in the preschool and school age group until the introduction and exclusive use of toxoid.

That being a fact, it should not be anticipated that the widespread use of immune serum will adequately control the problem of poliomyelitis, a problem beset with more complexities and difficulties than was the problem of diphtheria in the past thirty years. In poliomyelitis we have no specific practical laboratory test for the presence of the virus, as we have in diphtheria; the clinical picture is less pathopronomic, and the necessity for early use of serum before its administration is useless is at least as urgent as the necessity for haste in diphtheria, while the supply of serum is much more restricted. In the present stage of our knowledge of poliomyelitis, therefore, we must look for a significant, in fact a large addition to the number of crippled persons in Canada, in spite of the broadening use of immune serum. It is estimated that one-third of our cripples are so because of poliomyelitis. No means of specific immunization and, therefore, no adequate means of control, as far as we can recognize it to-day, is in sight.

Recognition of this fact makes it imperative that every physician, orthopedic surgeon and public health official should thoroughly peruse the communications by Dr. Macnamara in this issue. For the child who has been left with paralysis the problem of poliomyelitis does not end and is not mitigated with the advent of winter. The child's future problem depends upon the treatment that he gets after he is paralysed. The child's capacity to provide for himself, to avoid becoming a public

charge, depends on that treatment—and that treatment depends, in a large part, on the knowledge and skill of the attending physician and the orthopedic surgeon. An attitude of hopelessness, a belief that nothing can be done but later remedial operations, leads to unnecessary crippling. On the other hand, proper treatment given gromptly—and even, in some cases, delayed—restores the child to its former physical condition or leaves it with so slight residua that its later life is not impaired. The necessity for providing such treatment is urgent and the responsibility for providing it rests upon all branches of organized medicine—the general physician, the surgeon, the officials of the public health social services, the university and the teaching hospital.

Dr. Macnamara aptly quotes "What are we trying to do?" and "Are we doing it?" Seeing our cripples increasing as they are, seeing paralysis untreated, or treated too late, or inadequately treated, we are almost forced to admit that we are not "doing it."

N. E. McKinnon.

ANOTHER WARNING

IT is not for the lack of evidence concerning the danger of municipal supplies of unpasteurized milk that the menace of raw milk continues in such a large percentage of our municipalities. In this issue Dr. Frederick S. Leeder's paper on the outbreak of milk-borne typhoid fever presents in a clear and striking manner the danger which is ever present in unpasteurized milk supplies. This outbreak occurred in a milk supply which was from an inspected, tuberculin-tested herd. The cause was a carrier. There were twenty-five cases, with two deaths, among the ninety-four persons supplied.

Surely this epidemic, so complete in its epidemiological investigation, would be sufficient in itself to incriminate all raw milk supplies. No truer statement of the need for pasteurization can be written than the following concluding paragraph from Dr. Leeder's paper:

"Important as the tuberculin testing of cattle and the periodic analyses of milk samples are, particularly in assuring the production of clean milk from healthy cows—a milk fit to be pasteurized—they do not protect from milk-borne typhoid fever. To safeguard the public health and to assure the consumer of a good product, milk regulations should require that milk sold within a town be: 'From tuberculosis-free herds; from inspected sources; of good quality; and pasteurized'."

NEWS AND COMMENTS

P. A. T. SNEATH, M.D., D.P.H.

A.P.H.A. Meeting

AT the recent annual meeting of the American Public Health Association which was held in Washington from October 24th to 27th, three honorary life members were elected: Dr. James E. Monger, Philadelphia; Dr. John A. Amyot, C.M.G., Ottawa; and Dr. H. E. Young, LL.D., Victoria, B.C. The honouring of two outstanding Canadians will be greatly appreciated by the Association's members throughout Canada.

Among the Canadian representatives at the meeting were Miss Alice Ahern, Ottawa; Dr. W. J. Bell, Toronto; Dr. Brodie, Montreal; Dr. M. R. Bow, Edmonton; Dr. S. Boucher, Montreal; Mr. N. L. Burnette, Ottawa; Dr. L. H. Douglass, London; Dr. W. S. Downham, London; Dr. H. C. Cruikshank, Toronto; Dr. D. V. Currey, St. Catharines; Dr. R. D. Defries, Toronto; Dr. D. T. Fraser, Toronto; Dr. N. MacL. Harris, Ottawa; Mr. C. H. Mitchell, London; Mr. McCrady, Montreal; Dr. J. T. Phair, Toronto; Miss Laura C. Pepper, Ottawa; Miss Mary Power, Toronto; Mr. A. M. Towe, London; Dr. Wm. Warwick, St. John, N.B.; and Dr. James Wyllie, Kingston.

Infant Mortality in Canada

ACCORDING to statistics recently issued by the Bureau of Statistics, infant mortality in Canada is decreasing. The rate in 1926 was 101.8 per thousand, while in 1921 it was 84.8. Still-births are not included in these figures. Quebec's rate decreased from 142.0 in 1926 to 112.9 in 1931, but is still the highest in the Dominion. The lowest is that of British Columbia which is 49.7.

In Alberta the rate has declined from 85.3 in 1926 to 69.7 in 1931; in Saskatchewan, from 81.1 to 69.0; in Manitoba, from 76.5 to 64.3; in Ontario, from 78.4 to 69.8; in New Brunswick, from 105.9 to 87.4; in Nova Scotia, from 80.3 to 78.8; and in Prince Edward Island, from 70.2 to 68.1.

Of the four largest cities, Winnipeg, with 48.1 in 1931, has the lowest rate. Vancouver follows with 64.3 and Toronto is third with 69.8. The rate in Montreal in 1931 was 114.1.

Relief Figures

ACCORDING to figures presented to Parliament by the Hon. Wesley D. Gordon, Minister of Labour and Mines, more than 800,000 persons in Canada were receiving relief. This figure includes 144,000 who, according to Government figures covering the ten-year period from 1919, had been, on the average, unemployed. Included also are transients to the number of 140,000.

British Columbia

DR. JOHN R. NADEN of Princeton, has been appointed Medical Health Officer for Princeton and district in place of Dr. R. S. Manson, who has resigned.

Saskatchewan

DR. T. D. KENDRICK is directing the work of the Division of Vital Statistics, following the retirement of Mr. Stuart Muirhead.

Ontario

THE many friends of the late Dr. Wm. B. Brebner learned with deep regret of his untimely death on November 9th in New York, while engaged in research studies in poliomyelitis. An obituary notice will be published in the December JOURNAL.

Since the inception, almost a year ago, of the special efforts to reach preschool children in Toronto through the provision of clinics throughout the city, 10,597 first injections, 9,418 second injections, and 8,748 final in-

jections of toxoid have been given (to November 12th).

On November 1st the national office of the Canadian Nurses' Association was moved from Winnipeg to Montreal. On January 1, 1933, Miss Ethel Johns, R.N., will become editor and business manager of the Association's official journal, *The Canadian Nurse*. Miss Johns, a graduate of the Winnipeg General Hospital, has studied nursing conditions, particularly in the field of public health nursing, in Central Europe and the Balkan countries, under a fellowship of the Rockefeller Foundation, and recently organized a programme of nursing service for the New York City Hospital — Cornell University Medical Centre. Mis John's appointment will make it possible for the Executive Secretary to devote all her time to the functioning of the Association itself.

For purposes of tuberculosis examination, five hundred first-year students at McGill University are being X-Rayed by the Department of Physical Education. The X-Ray photographs will be carefully studied and filed, in order that a complete history of the health of these students may be kept all through their course. In this way it will be possible to determine how tuberculosis attacks students and what percentage is affected.

Miss R. G. Bryan, R.N., for twelve years Superintendent of Nurses at the Ontario Hospital, Whitby, has been transferred to the Ontario Hospital at Cobourg. Miss D. Fiddler, of the Toronto Psychiatric Hospital, has been appointed to replace Miss Bryan.

Nova Scotia

DR. HARRY G. GRANT, who has succeeded Dr. John Stewart as Dean of the Faculty of Medicine of Dalhousie University, Halifax, was previously connected with the Department of Health, Virginia, as a member of the International Health Division of the Rockefeller Foundation. Himself a graduate of Dalhousie in 1912, he was lecturer in medicine there from 1921 to 1925. In addition to serving as Dean, Dr. Grant will be Professor of Public Health.

Newfoundland

REDUCTIONS in governmental expenditures of more than $750,000 are necessary in order that Newfoundland may meet obligations falling due on December 31st. This is in addition to a curtailment of $145,000 effected in July. As a result, $200,000 more has been deducted from the appropriation of the Department of Health.

According to a report of Dr. R. A. Braham, more than 200 cases of scarlet fever have been reported, of which 44 have been hospitalized. Several deaths have been reported.

REPORTED CASES OF CERTAIN COMMUNICABLE DISEASES IN CANADA* BY PROVINCES—SEPTEMBER, 1932.

Diseases	P.E.I.	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia
Diphtheria	6	8	3	94	98	39	9	1	—
Scarlet Fever	—	5	12	164	76	64	7	14	35
Measles	—	13	1	59	127	16	7	71	23
Whooping Cough	—	13	—	349	380	104	57	9	29
German Measles	—	—	1	28	6	†	2	—	1
Mumps	—	10	—	11	157	4	2	1	16
Smallpox	—	—	—	—	3	—	6	—	—
Cerebrospinal Meningitis	—	—	1	1	2	9	—	—	2
Anterior Poliomyelitis	—	—	3	316	53	3	—	7	2
Typhoid Fever	—	2	10	191	94	25	9	3	10
Trachoma	—	—	—	—	2	26	6	—	4

*Data furnished by the Dominion Bureau of Statistics, Ottawa.
†Not reportable.

Books and Reports

D. T. FRASER, B.A., M.B., D.P.H.; R. R. MCCLENAHAN, B.A., M.B., D.P.H.

The Cardiac Output of Man in Health and Disease. *By Arthur Grollman, Ph.D., M.D. Publisher, Charles C. Thomas, 220 East Monroe Street, Springfield, Illinois, 1932. 325 pages. Price $4.00 postpaid.*

Dr. Grollman, Associate Professor of Physiology in the Medical School of the Johns Hopkins University, has provided us with one of the best monographs dealing with cardiac physiology that has been published. This book, containing 57 tables, 25 figures and 483 references, deals with the studies of the circulatory system from the standpoint of cardiac output. The importance of an understanding of the problems relating to the circulatory system in health and disease is being stressed more to-day than ever before.

From a vast experience in cardiac physiology, the author discusses the technical details and procedures used for applying cardiac output studies to man in health and disease. The various methods are evaluated and emphasis is placed on the acetylene method. The physiological variations of the cardiac output due to posture, injection of food and fluids, sleep, muscular exercise, altitude, etc., as well as the pharmacological and therapeutic effects of alcohol, caffeine, tobacco, digitalis, adrenalin, histamine, the endocrines and many others, are all dealt with fully.

The author and his publisher, Charles C. Thomas, have made available a book that is well indexed and beautifully printed, and one that should be read by all students, teachers and others interested in heart disease. D. L. Mc.L.

Cancer, What Everyone Should Know About It. *By James A.*

Tobey, Dr.P.H., with introductions by Joseph Colt Bloodgood, M.D., and H. L. Mencken. Publisher, Alfred A. Knopf, 730 Fifth Avenue, New York, 1932. 310 *pages and index. Price* $3.00.

Whatever may be the opinion of medical men regarding the desirability of placing books on medical subjects in the hands of the layman, there can be no serious objection in that regard to this book. As Bloodgood states in the introduction, "This book is presented to the reading public throughout the world with the authority of the literature on malignant diseases and the personal authority of cancer students behind it." The devastating aspects of cancer are better known to the public than the encouraging records of its control. The book will do much to enlighten people in this respect. The style is lucid and the interest well sustained. Altogether, the book is well adapted to its purpose. D. T. F.

Essentials of Pediatric Nursing. *By Ruth Alice Perkins, R.N., B.S. Second edition, revised and enlarged. Publisher, The F. A. Davis Company,* 1914-16 *Cherry Street, Philadelphia, Pa.,* 1932. 153 *pages. Price* $1.50.

This book is an excellent outline of paediatrics from a nursing standpoint. It is fairly concise and emphasizes very well the important aspects of nursing both the sick and the well child. The accompanying illustrations are well chosen and the author has given short synopses of many of the diseases of infancy and childhood.

The publication is a most practical one for the nurse interested in the care, feeding and management of children.

BOOKS RECEIVED

Nursing in Nervous Diseases. By James W. McConnell, M.D. Publisher, The F. A. Davis Company, 1914-16 Cherry Street, Philadelphia, Pa., 1932. 153 pages. Price $1.50.

Community Health Organization. Edited by Ira V. Hiscock for the Committee on Administrative Practice of the American Public Health Association. Publisher, The Commonwealth Fund, Division of Publications, 41 East 57th Street, New York, 1932. 261 pages. Price $2.50.

Milk Production and Control: Communicable Diseases, Public Health Supervision, Nutritional Aspects, Economic Aspects. Report of the Committee on Milk Production and Control, White House Conference on Child Health and Protection. Publisher, The Century Co., 353 Fourth Avenue, New York, and London, 1932. 392 pages. Price $3.00.

Fungous Diseases. A clinical-mycological text by Harry P. Jacobson, M.D., Jay Frank Schamberg, M.D., and Howard Morrow, M.D. Publisher, Charles C. Thomas, 220 East Monroe Street, Springfield, Ill., 1932. 317 pages. Price $5.50.

Classic Descriptions of Disease. By Ralph H. Major, M.D. Publisher, Charles C. Thomas, Springfield, Ill., 1932. 630 pages. Price $4.50 postpaid.

The Child and the Tuberculosis Problem. By J. Arthur Myers, Ph.D., M.D., F.A.C.P., with an introduction by William P. Shepard, M.D., F.A.P.H.A. Publisher, Charles C. Thomas, Springfield, Ill., 1932. 230 pages. Price $3.00 postpaid.

Hospitals and Child Health. Reports of the Sub-Committees on Hospitals and Dispensaries, Convalescent Care and Medical Social Service. White House Conference on Child Health and Protection. Publisher, The Century Co., 353 Fourth Avenue, New York, and London, 1932. 279 pages. Price $2.50.

CURRENT HEALTH LITERATURE

These brief abstracts are intended to direct attention to some articles in various journals which have been published during the preceding month. The Secretary of the Editorial Board is pleased to mail any of the journals referred to so that the abstracted article may be read in its entirety. No charge is made for this service. Prompt return (within three days) is requested in order that the journals may be available to other readers.

Milk Irradiated by the Carbon Arc Lamp—Pasteurized milk was activated under carefully controlled physical conditions by means of carbon arc rays. Clinical tests of the irradiated milk demonstrated it to be highly effective in the prevention and in the cure of infantile rickets. On the other hand, laboratory tests showed that the milk contained a comparatively small number of antirachitic units as judged by the standard rat assay. In view of the excellent clinical results obtained with the irradiated milk, the authors consider that the standard method of assay cannot be relied upon to appraise the value of irradiated milk for infants.

Hess, A. F., and Lewis, J. M., *J.A.M.A.*, *99*: 647 (Aug. 20), 1932.

Incidence of Tuberculosis in the Tonsil—This paper contains a brief review of tuberculosis of the tonsil and a report on a series of tonsillectomies in sanatorium and preventorium patients. Primary tuberculosis of the tonsil (usually unaccompanied by gross changes), occurs infrequently in communities where the milk is pasteurized, but an incidence as high as 12 per cent in children fed on unpasteurized milk has been reported. The author, in an examination of tonsils from 21 children in an area in which the milk supply is completely pasteurized, failed to find evidence of tuberculosis in them.

Heaton, T. G., *Canad. M.A.J.*, *27*s 274 (September), 1932.

The Occurrence of Boils among Men Working in Coal Mines—Men employed in coal mines occasionally develop boils in such numbers as to suggest a mild epidemic. The outbreaks have been studied and the evidence obtained indicates that a high wet bulb temperature (75° and over) is the main causative factor, inducing free sweating and thus facilitating staphylococcic infection of the skin.

Fisher, S. W., *J. Indust. Hy.*, *14*: 243 (Sept.), 1932.

Trachoma in Canada—Trachoma is now rare in the eastern provinces of Canada, but a serious situation exists in Saskatchewan and Manitoba. The non-Indian population affected in these provinces are Russians and Mennonites, there being 1,082 cases in Manitoba and a greater number in Saskatchewan. The disease is extremely prevalent among the Indians of British Columbia and the Prairie Provinces and the number of cases possibly reaches 10,000. Dr. Byers outlines the steps which have already been taken to combat this disease.

Byers, W. Gordon M., *Canad. M.A.J.*, *27*: 372 (Oct.), 1932.